ANNALS OF SURGERY

VOL. LII DECEMBER, 1910 No. 6

ORIGINAL MEMOIRS.

THE TREATMENT OF SCALPING ACCIDENTS.*

REPORT OF TWO CASES OF SCALPING BY MACHINERY, WITH A CONSIDERATION OF SCALPING ACCIDENTS IN GENERAL.

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IN text-books and systems of surgery scalping is generally considered under "Lacerated Wounds of the Scalp," but it is undoubtedly a lesion whose treatment requires much more careful study and attention than is usually accorded it.

This paper is based upon a critical review of the literature, my own experimental work, and on two cases of complete scalping, which were healed by skin transplantation. On one of these cases, that of Dr. Bloodgood's, Thiersch grafts only were used, while on the other, which was my own, the healing was brought about entirely by whole thickness grafts.

I take this opportunity of thanking Dr. Halsted for the use of the cases from his clinic, reported in this paper, and also Drs. Cone, Porter, Roberts, and Spencer for allowing me to include in my series their unpublished cases of complete scalping.

REPORT OF TWO UNPUBLISHED CASES.

CASE I (Dr. J. C. Bloodgood).—Admitted to the Church Home and Infirmary on August 24, 1906. Diagnosis: complete

* The full text of this paper with detailed case reports, bibliography, etc., will appear in vol. xvi of the Johns Hopkins Hospital Reports.

scalping by machinery. Treatment: grafting with Thiersch grafts. Result: recovery.

Clinical History.—White, female, aged 41 years, operator in a canning factory.

Family and Personal History.—Unimportant.

Physical Examination.—This was negative, except as noted below.

Present Illness.—On August 21, 1906, the patient caught her hair on a rapidly revolving shaft, which was directly over her head, and was completely scalped. The line of tearing included both eyebrows and extended backwards, just above the ears, to below the hair line on the neck. There was some laceration of the right ear and several periosteal defects, but no other injury. There was no loss of consciousness, but the pain was very severe. The hemorrhage was marked. No attempt was made to replace the scalp.

On admission to the hospital the patient was in a fairly good physical condition. Red blood-corpuscles 4,400,000, hæmoglobin 80 per cent. She was suffering considerable pain. The head was dressed with wet salt solution dressings, and the eyes were irrigated with boric solution.

September 13, 1906: The growth of the granulations was exceedingly slow, but in spite of this it was decided to graft. Large Thiersch grafts, obtained from a young woman, 19 years old, were applied by Dr. Follis. The result was total failure, which was probably due to the unsatisfactory condition of the granulation tissue.

By the use of the following technic good healthy granulations were produced. A single layer of dry gauze was placed over the wound, and this was covered with rubber protective. This dressing was changed every other day. The granulations were stimulated by the gauze and were held flat by means of the protective. In about two months the granulations were in excellent condition and there was a growth of epithelium one-fourth of an inch wide around the edges of the wound.

November 15, 1906: Operation, Dr. Bloodgood, assisted by Dr. Follis; ether anæsthesia. The entire granulating surface was swabbed with pure carbolic acid followed by alcohol. The left half of the wound was freely scarified with a knife and, after the hemorrhage was checked, was covered with large autodermic Thiersch grafts. The grafts were dressed with silver foil, over

which was placed collodion and little strips of gauze, then more collodion, silver foil, and more gauze. The ungrafted portion of the head was covered with boric ointment, collodion, foil, and gauze, completing the cap, which was held snug by straps of adhesive plaster. Practically all of these grafts were successful.

December 6, 1906: The right half of the head was prepared, grafted, and dressed in a similar manner, with equally good results. The grafts were cut by the modified Thiersch method used at the Johns Hopkins Hospital.

Ulcerations appeared here and there on the grafted area, but these soon healed. The patient was discharged on March 8, 1907, with the newly grafted area in excellent condition (Fig. 1).

Examination of the Patient on March 17, 1910.—The head was covered with a smooth, thin, shiny, movable skin, in which could be seen numerous blood-vessels. On the vertex were five or six small ulcerations, the largest being about the size of a ten-cent piece. These ulcers were sometimes painful. She said that small ulcerations had occurred from time to time ever since leaving the hospital.

There was normal sensation over practically the entire grafted area. There was no retraction of the eyebrows and the eyelids could be closed normally. The patient was continually bothered by the sensation of a heavy weight pressing on the top of her head, and she said that she could not lean over without a feeling of great tightness in the same area.

CASE II.—The case described below was referred to me for treatment through Dr. J. M. T. Finney. The history before the patient came under my care was obtained partly from the family physician, Dr. A. H. Montgomery, of Montgomery, Alabama, and partly from the patient herself.

On July 29, 1907, Miss X caught her hair on a rapidly revolving shaft under which she had inadvertently walked. The shaft was above her and on her left side. She was lifted up and when the scalp gave way she fell back to the floor. There was little immediate pain but the hemorrhage was profuse, although of short duration. There was no loss of consciousness. She did not realize that the scalp was gone until she put her hand to her head.

Examination showed that the scalp had been torn off from the hair line in front to the hair line behind, including the entire occipitofrontalis muscle, and the line of tearing extended from immediately above the right ear to below and including the left

ear, and also an area of skin on the cheek below and in front of it. The skin of the forehead was hanging down over the eyes. This was sutured to the periosteum and the wound cleaned as well as possible. Three bleeding points were tied. There was a defect in the periosteum in the left frontoparietal region. No other injury was found. No attempt was made to replace the scalp. The head was dressed with rubber tissue and sterile gauze.

There was very little pain on the night of the accident, but on the day following and continuing for two weeks the suffering caused by the dressings was very severe. The pain was localized in two spots just below the superior curved line of the occipital bone about one inch from the middle line on each side, and there was also a sensation of strong pulling.

Six weeks later skin was taken from her thighs after the method of Thiersch and was placed on the front part of the wound, on the lobe of the left ear and on the triangular space below it. The result of this grafting was not satisfactory. No further grafting was attempted until the following year.

On August 13, 1908, after careful preparation, Thiersch grafts from a lamb were applied. In September strips of whole thickness lamb skin were transplanted. About one month later guinea-pig skin was used, and two months later lamb skin was again tried. All of the grafts were placed on the periosteum following the removal of the granulations, and all were unsuccessful.

The patient came under my care on May 1, 1909, and was admitted to the Union Protestant Infirmary on that date.

Diagnosis: granulating wound following complete scalping by machinery. Treatment: grafting with whole thickness sessile skin flaps. Result: recovery.

Clinical History.—White, female, aged 24 years, milliner.

Personal and Family History.—Unimportant.

Physical Examination.—This was negative, except as noted below.

When the dressing was removed a mass of fungating gelatinous granulations, which bled easily, was exposed. These were very exuberant and the entire mass could be moved by resting the hand on the vertex and gently making excursions from side to side. This area measured in the middle line from front to back 23 cm., and from ear to ear 28 cm. It was surrounded by a cicatrizing border about 1 cm. in width. The left ear was

lacking except for a small part of the lobe. The outline of the ulcer can be well made out in Fig. 2, taken three weeks after admission.

May 1 to May 28: The wound was thoroughly cleaned. The patient was put on forced feeding and tonics, and also was required to live and sleep out of doors, in order to secure the best physical condition.

Within a short time, following the free use of nitrate of silver stick and tincture of iodine, the character of the granulations decidedly changed. After these applications the patient was placed in the sunshine, which was allowed to fall directly on the granulating area. The time of this exposure varied from half an hour at first to the entire day. After the exposure the wound was dressed with balsam of Peru, 2 parts, and castor oil, 6 parts, on an adjustable cap (Figs. 3 and 4).[1] There was no pain whatever connected with these dressings.

I decided to use only whole thickness grafts in order to get a more lasting, durable healing.

June 3: Whole thickness grafts 20 x 4.5 cm. were removed from each thigh, after blocking the external cutaneous nerves.

June 15: Whole thickness grafts 16 cm. long by 7 cm. wide were taken from both sides of the lax abdominal skin, under local anæsthesia with Schleich's solution. All of these flaps were removed with the subcutaneous fat, and dry technic was carefully observed throughout. The fat was removed and the flaps were freely button-holed and placed on undisturbed granulations. Over the grafts, and overlapping the healthy skin and uncovered granulating areas, rubber impregnated mesh was placed. The ends were twisted and secured by adhesive plaster. The grafts were dressed with normal salt solution for 48 hours. The mesh was kept in place for about one week. All of these grafts were successful (Fig. 5).

June 24: Several large pieces of whole thickness skin, obtained from a ventral hernia case, were applied six hours after removal. This skin had been chemically cleansed and a large part of it was scar tissue. It was treated and dressed in the usual manner. These grafts seemed to take throughout, but later a considerable portion sloughed.

June 30: Whole thickness grafts 22 x 5 cm. and 20 x 4.5 cm.

[1] This cap was devised by Miss E. Bowman, the nurse in charge of the patient at the Union Protestant Infirmary.

were obtained from the thighs under local anæsthesia, and were treated as usual. These were successful. All the grafts were exposed to the air after the first 48 hours, and were anointed with either Porter's ointment [2] to prevent drying out or with scarlet red 8 per cent. along the margins.

During the next two months a number of small superficial ulcers appeared in the cicatrix which formed before grafting was commenced, and a number of granulating areas were left by the sloughing of the isodermic grafts.

August 30: Under nitrous oxide anæsthesia whole thickness flaps from both legs, 20 x 4.5 cm., and from the abdomen, 15 x 4 cm., were removed and treated in the usual manner. It was necessary to divide the flaps in order to fit them into the irregular shaped areas. Practically all of these grafts were successful.

September 25: Several resistant ulcers appeared in the marginal cicatrix, and these were successfully grafted with small deep grafts, which were dressed with narrow overlapping strips of rubber protective.

October 8: Similar grafts were placed on three small areas where one of the thick grafts had been very slow in "topping off."

October 23: Another small ulcer in the cicatricial tissue was grafted with small deep grafts. All of these grafts were successful.

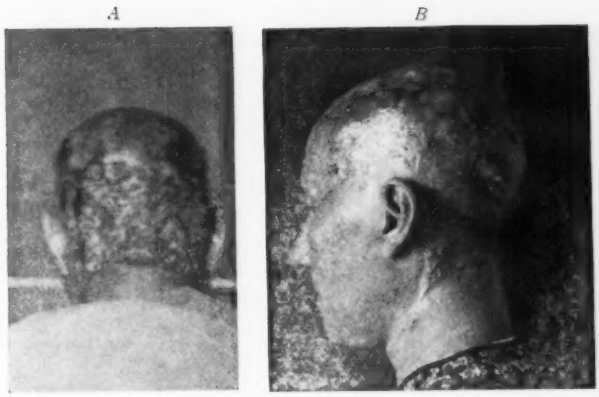
When discharged, November 16, 1909, the scalp presented the following appearance: The denuded area was entirely healed (Fig. 6). The greater part was covered with stable whole thickness skin, which was normal in appearance and was soft and movable. Acute sensation was practically confined to the cicatricial border around the grafted area. There was definite growth of fine hair on those grafts which were obtained from the thighs and legs, showing that the skin with all that belonged to it was transplanted.

The general condition of the patient was excellent, and with the aid of a wig a good cosmetic result was obtained (Fig. 7).

A comparison of these two cases is interesting. Both were females, aged respectively twenty-two and forty-one

[2] Porter's ointment: citrate of silver 1 part; ichthyol, 4 parts; benzoinated lard, 175 parts; lanolin, 25 parts (ANN. OF SURG., November, 1907, p. 660).

FIG. 1.



A, before grafting; *B*, result of grafting with Thiersch grafts (Bloodgood's case).

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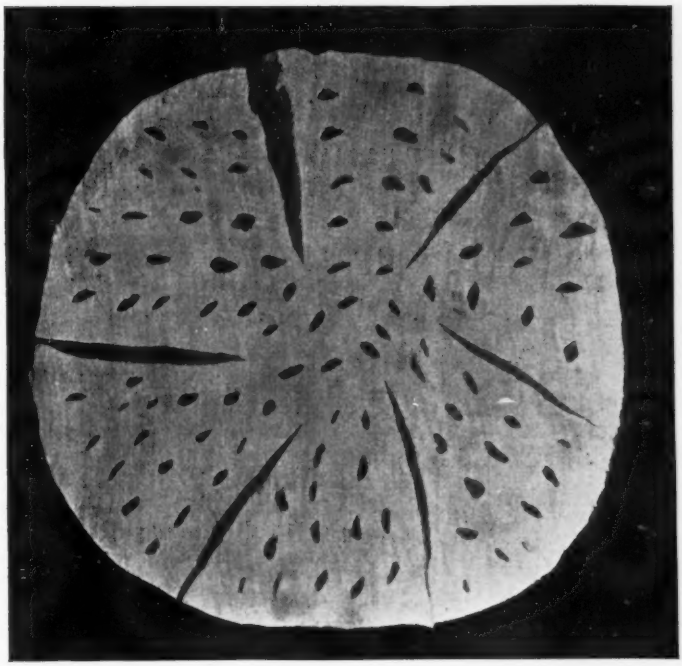
FIG. 2.

The denuded area three weeks after admission to the Union Protestant Infirmary. The granulations are clean, healthy, and nearly ready for grafting. The narrow zone of cicatrization can be seen, which shows the extent of the healing from the edges since the accident occurred 22 months before, and emphasizes the slowness of healing by cicatrization. Case II.

FIG. 3.



Adjustable cap made of old linen which is button-holed to allow the escape of secretions. The diameter is 12 inches. The cap can be saturated with oily dressings, or ointments may be spread on it.

FIG. 4.

The adjustable cap shown in Fig. 3 in position. The use of this cap simplifies the dressing of the rounded granulating surface.

FIG. 5.

A portion of the first and second graftings. The first graft, which is in front, has nearly assumed the level of the normal skin, while the one behind it is still considerably thickened. The large button-holes in the second graft can be plainly seen. Case II.

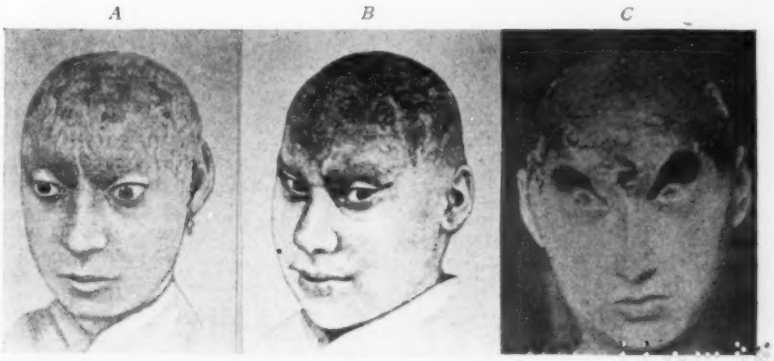
FIG. 6.

Side views, completely healed by whole thickness grafts. Case II.

FIG. 7.

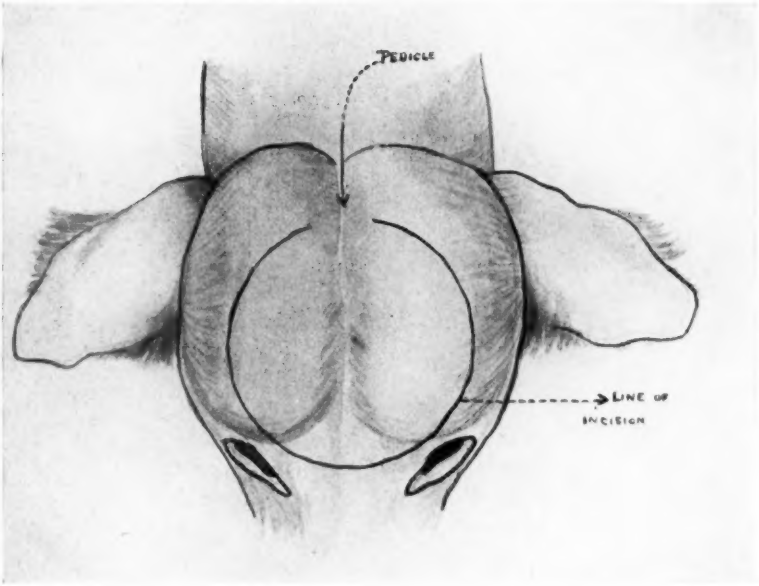
Patient with wig on. Photograph taken one month after leaving hospital. Case II.

FIG. 8.



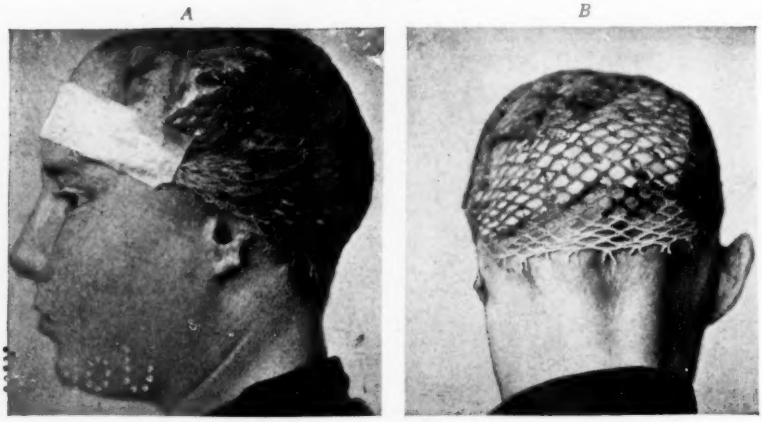
Different grades of retraction of the eyebrows. *A*, Franchomme and Parisot's case, slight retraction. *B*, Fouchard's case, note Mongolian expression. *C*, Durand's case, marked ectropion.

FIG. 9.



Outline of the incision made in pedunculated flap experiments.

FIG. 10.



A, the rubber impregnated mesh holding whole thickness grafts in position on the posterior portion of the wound. Note the gathering in of the ends of the mesh, which are secured by adhesive strips. *B*, note the accurate fitting of the grafts and the snugness of the mesh.

years. Both accidents occurred in manufacturing plants and were due to rapidly revolving shafts which were unboxed.

In Case I the *line of tearing* included both eyebrows, while in Case II the tearing began at the hair line. In Case I there was slight laceration of the right ear, while in Case II the left ear was torn off and also a portion of the cheek was involved. In both cases the tear was across the neck and not in a point to the root of the neck.

There was no *loss of consciousness* in either case. There was marked *hemorrhage* in both cases, but of comparatively short duration. It was necessary to *tie the arteries* in Case II. In Case I the *immediate pain* was intense, while in Case II it was so slight that the patient was unaware that her scalp was avulsed. The *subsequent pain* was severe in each but disappeared within a short time. There were *periosteal defects* in both but without subsequent *exfoliation of the bone.* There was little or no *shock* in either. No attempt was made to *replace the scalp* in either case. In both cases the first growth of granulations on the periosteum was exceedingly slow.

Twenty-one months had elapsed after the accident before Case II came under my care, and during that time autodermic Thiersch grafts and both thin and thick zoodermic grafts had been unsuccessfully tried. There had been a slight growth of epithelium about 1 cm. in width around the wound edges.

In comparing the condition of the wounds, the types of grafts used, and the results obtained in the treatment of these cases, I will consider in Case II only the treatment carried out after May 1, 1909, at which time the patient came under my care.

The pictures presented by these two cases are very different. In Case I the difficulty was in stimulating the growth of the granulations before attempting to graft, while in Case II (21 months after the accident), the problem was how to deal with badly infected, exuberant, œdematous granulation tissue, and to bring it into a suitable condition for grafting.

In Case I only Thiersch grafts were used, while in Case II only whole thickness grafts were employed. Isodermic grafts

were tried in both, but were unsatisfactory except for a partial take in Case II. Autodermic grafts, on the other hand, were uniformly successful. The grafts in Case I were placed on scraped granulations, while in Case II all the grafts were applied to undisturbed granulating areas. The Thiersch grafts applied in Case I were cut under ether anæsthesia by the method employed at the Johns Hopkins Hospital, and wet technic was used. The greater number of whole thickness grafts on Case II were obtained under local anæsthesia, and dry technic was carried out as far as possible. Both cases were in the hospital about the same length of time.

In Case I small ulcerations appeared here and there over the grafted surface, off and on, after discharge from the hospital. In Case II small ulcerations appeared while in the hospital and one or two later, but these were on the ungrafted scar tissue, and not on the grafted surface.

I was fortunate enough to have an opportunity of examining Case I three years after her discharge from the hospital, and could in this way make a relative comparison of the healing brought about by Thiersch grafts and by whole thickness grafts.

The grafted surface in Case I was covered with a smooth, thin, shiny skin, which was freely movable over nearly the entire area. On this were several superficial ulcers. The patient said that these ulcers would heal slowly and then other areas would break down, so that ever since her discharge there had been one or more ulcers.

Sensation was present practically over the entire grafted area, and there has been constantly a feeling of weight on the vertex.

The grafted area in Case II, at time of discharge, was covered with stable whole thickness skin, which was normal in appearance and was soft and movable. The grafts which had lost their superficial layers were somewhat more pinkish, but were equally stable, and there seemed very little likelihood of ulceration.

The marginal cicatrix and areas of scar tissue were much less stable and more likely to break down.

Since discharge the patient writes that a small ulcer would occasionally appear in this scar tissue, but never in the grafted area.

Acute sensation was confined to the cicatricial border, and there were no uncomfortable sensations of weight or tightness.[3]

From the above, one can see at a glance that Case II was in better condition at time of discharge than Case I even after three years had elapsed, which convinces me that whole thickness grafts are the most satisfactory in the treatment of these cases.

HISTORICAL DATA.

It is generally supposed that the practice of scalping was peculiar to the American Indian, but it has been shown by Burton that this custom was not uncommon among the Asiatics, Europeans, and Africans, from the earliest times.

Friederici believes that the custom of scalping was unknown among Mongolians. He says that scalping is mentioned twice in the Bible, II Maccabees, 7, 7, and Deuteronomy, xxxii, 42, but that there is nothing at all in the original and in the Septuaginta which could be interpreted as showing the existence of the custom of scalping among the Israelites; furthermore, that Herodotus gave the only clear description of a scalping people (Scythians) of the old world, and that everything else on this subject appertains only to hints, beginnings, or remnants.

The Abbe Em. Domenech ("Seven Years' Residence in the Great Deserts of North America," chap. 39) quotes the "decalvare" of the ancient Germans, the "capillos et cutem detrahere" of the code of the Visigoths, and the Annals of Fluor (Flude) to prove that the Anglo-Saxons and the French still scalped about A.D. 879.

Friederici says, after an extensive investigation, he has been unable to confirm these annals.

[3] On September 26, 1910, the patient writes that her head is in splendid condition, and that she is working. Sensation is present over the entire grafted area, and is normally acute 2¼ inches beyond the cicatricial border. This shows quite rapid progress from the edges of the wound. Small superficial ulcers still occasionally occur in the scar tissue, otherwise there is no trouble whatever.

There is no doubt but that the American Indians were accustomed to scalp their enemies long before the discovery of this country by Columbus, and each tribe had its own method of scalping which was passed down from generation to generation. The amount of scalp removed, by the different tribes, varied from about the size of the tonsure of a monk to the whole scalp.

Up to thirty years ago scalping by Indians was of common occurrence on our Western frontier, although the cases were seldom reported in medical literature, but of late years this method of scalping has, happily, become exceedingly rare. Industrial scalpings, on the other hand, have increased in number, and in the last fifty years the majority of cases reported in medical literature have occurred in manufacturing centres, and when scalping is spoken of to-day industrial scalping is usually meant. The number appears to have increased chronologically with the greater development of machinery and manufacturing plants.

The number of cases is not great, and in over 26,000 house cases admitted to the Johns Hopkins Hospital, in the service of Dr. Halsted, there has not been a single case of complete scalping.

The first case of scalping due to machinery, recorded in medical literature, is that of Downs, which occurred on June 23, 1838.

Netolitzki was the first to employ grafts in the treatment of scalping, and on April 11, 1869, transplanted small elliptical shaped pieces of whole thickness skin from the back of the patient's hand. Later, on the same wound, Phillipp tried zoodermic grafts from various animals, for the first time on such a case.

Bartlett, in 1871, was the first in the United States to employ autodermic Reverdin grafts in the treatment of scalping. This also seems to be the earliest recorded case of scalping thus treated.

Socin, in 1889, was the first to employ Thiersch grafts in the treatment of scalping.

The *anatomy of the scalp* will not be considered here, on account of lack of space.

DEFINITION, ETIOLOGY, MECHANISM.

There have been many definitions of scalping, for the most part based on the amount of scalp avulsed, but a simple and satisfactory idea of the injury may be expressed as follows: By scalping we mean the forcible separation of the scalp from the cranial vault by a violent, quick force, from which results a tearing of the skin, with little or no mutilation of the surrounding teguments.

There are two clinical varieties of scalping: *incomplete,* where the whole or a portion of the scalp is separated from the vault, although it remains attached to the adjacent skin by a pedicle, which may be more or less extensive; *complete,* where the whole or a portion of the scalp is entirely separated from the cranial vault and the adjacent skin. There are several grades of each of these varieties, depending on the amount of the scalp involved.

Special conditions are necessary for the production of this accident by machinery. The patients have been almost exclusively workers in factories, and all have been females, with the exception of one case, a Chinaman, who caught his queue in revolving machinery and was totally scalped.

The scalp is caught between two forces which oppose each other, the force of the machine and the speed of rotation, against the weight of the body and the struggles of the individual. Violent and quick traction is necessary. By the strong pull on the hair, at first there is separation between the galea and the periosteum. The scalp does not give way until its elasticity has reached its limit, when the muscle parts and the skin tears. The line of separation is, as a rule, at the junction of the scalp with the skin of the face and neck, or in other words where it is thinnest, and in many instances it finishes low on the neck, in Spencer's case reaching the fourth dorsal vertebra.

The amount avulsed varies with the amount of hair caught and with the direction and intensity of the force. In incom-

plete scalping a pedicle is left at the point where the force was least, and therefore not where the tearing begins. If the pedicle is behind, the tearing begins in front, and vice versa.

A series of experiments, by Fouchard, were made on cadavers as follows: In the first series violent sudden traction was made on the scalp in a direction following the median axis of the body, by means of the plaited hair. Three attempts resulted in the tearing out of nearly all of the hair in each instance, without injury to the skin. The fourth, where the traction was not so strong and less sudden, produced no result.

In the second series the traction was operated in the same way, but the pull was made obliquely from back to front. Three attempts were made with a negative result in each, except for a limited tearing of the hair alone at the periphery of the zone of implantation.

In the third series, five experiments with traction from front to back produced five scalpings, two complete and three incomplete. The tearing in each case began at the superciliary ridges. Fouchard concludes that the tearing of the scalp is produced by a sudden and violent traction, which is exerted obliquely from front to back. The superciliary ridges act as the cutting instrument, and the skin is cut by them where it is thinnest, and the tearing follows toward the neck. He says this is the usual method in actual practice.

When the tearing begins at a different level, such as the hair line, the above described action does not occur, and the cause is obscure.

The only case in which the hair alone was pulled out without injury to the scalp was that of Vauthier, and it might be explained along the line of Fouchard's first series of experiments.

A comparison of the number of complete and incomplete scalpings by machinery is interesting, there being 80 complete and 10 incomplete.

The separation usually takes place in the loose subaponeurotic layer, but occasionally the periosteum is removed to a greater or less extent, and also the fleshy portions of the occipitofrontalis and temporal muscles.

The anatomic elements are easy to differentiate. The skin edges are remarkably clean and regular, and there is usually little or no mutilation of the surrounding tissues.

By the strict enforcement of certain rules, a large number of the recorded cases of scalping could have been avoided. The shafts and belts should be housed in as far as possible, or placed out of reach.

The female operators should be compelled to arrange their hair tightly, and always to keep it covered with a simple cap of some smooth material while in the working room.

ANALYSIS OF CASES.

Scalping due to burns, 8 cases. *Hair torn out without laceration of the scalp,* 1 case.

Complete Scalping, 91 cases.—*Scalping by Indians,* 7 cases. *Scalping by machinery,* 80 cases.

For convenience I have divided the cases of complete scalping, caused by machinery, into three general classes: first, those in which the line of tearing included one or both of the eyebrows; second, those in which the line of tearing passed above the eyebrows; third, those in which the line of tearing was not given.

Scalping by other forces, 4 cases.

Incomplete Scalping, 30 cases.—*Scalping by the claws of animals,* 2 cases. *Scalping in which the method of injury was not given,* 4 cases. *Scalping by machinery,* 10 cases. *Scalping by other forces,* 14 cases.

SUMMARIES.

Scalping due to burns, 8 cases. *Males,* 6; *females,* 2. The *youngest* was 7 months, and the *oldest* 50 years. *Age in decades:* Up to 9 years, 2 cases; 10 to 19 years, 1; 20 to 29 years, 2; 30 to 39 years, 1; 50 to 59 years, 1; no age stated, 1. *Date of cases in decades:* 1850 to 1859, 1 case; 1860 to 1869, 1; 1870 to 1879, 2; 1900 to 1909, 4. *Loss of consciousness* and *shock* were not stated. *Immediate pain,* very slight if any. *Periosteal defects at time of accident,* 8 cases. *Exfoliation of the bone,* 6 cases; both tables came away in 3; in 1 of which there was exfoliation of an area 5¾ x 4½ inches, and in another an area 17 x 11 cm. *Complications:* Cicatricial bands to sternum, 1 case; ectropion, 2;

erysipelas, several attacks, 1; sepsis, 1; abscess of brain, 1; convulsions due to pressure of scar on brain, 1; lowering of forehead due to continual pressure of scar tissue, 1. *Treatment and result:* Cases grafted, 2, both healed. *Type of grafts used,* not stated, 1; human skin and mucous membrane, rabbit, guinea pigs, dogs, and frogs, 1. *Healed by grafting* 2 cases; *healed by cicatrization,* 1; *unhealed,* 1; *result not stated,* 2; *died* 2. *Time of healing by grafting,* 4 years, 1; 1 year, 1; one case died from sepsis and the other from abscess of the brain. *Burned by coals,* 4 cases; *electricity,* 2; *carbolic acid,* 1; *boiling grease,* 1.

The absence of pain, shock, and general symptoms in the cases burnt by fire is quite remarkable. The reaction is more marked in the electric burns and carbolic acid burns.

Hair torn out without laceration of the scalp, 1 case. This case is unique, and is the only one on record caused by machinery in which the hair alone was torn out, leaving the scalp intact.

COMPLETE SCALPING, 91 CASES.

Scalping by Indians, 7 cases. These cases are interesting, and the treatment of boring with an awl the necrosed bone advocated by Robertson so many years ago is undoubtedly beneficial. To-day, however, in areas of any size, a small trephine or a Hudson burr will be found more advantageous than an awl.

Total Summary, Complete Scalping by Machinery.

Complete scalping by machinery, 80 cases. *Scalping in which the line of tearing included one or both of the eyebrows,* 53 cases. *Scalping in which the line of tearing passed above the eyebrows,* 19 cases. *Scalping in which the line of tearing was not given,* 8 cases. *Male,* 1; *females,* 79. The *youngest* was 9 years, and the *oldest* 57 years. *Age in decades:* 1 to 9 years, 2 cases; 10 to 19 years, 32; 20 to 29 years, 22; 30 to 39 years, 3; 40 to 49 years, 2; 50 to 59 years, 1. *Age not stated,* 18 cases. *Date of cases by decades:* 1830 to 1839, 1 case; 1840 to 1849, 1; 1850 to 1859, 1; 1860 to 1869, 7; 1870 to 1879, 16; 1880 to 1889, 7; 1890 to 1899, 21; 1900 to 1909, 26. Twenty-one of these cases have occurred in the United States. There was *loss of consciousness* in 6 cases. *Shock,* 14 cases; in 9 of these it was severe. *Immediate hemorrhage,* 16 cases, in 11 of which it was severe. *Subsequent hem-*

orrhage, 2 cases. *Arteries were tied* in 10 cases. *Immediate pain,* 12 cases, in 3 of these it was severe. *Subsequent pain* occurred in 5 cases, all being severe. There were *periosteal defects at time of accident* in 29 cases; in 4 the *entire periosteum* was torn off, and there was *exfoliation of the bone* in 2. In 21 the *size of the defect* was not stated; in 12 of these there was *subsequent exfoliation of the bone.* In 4 cases *very large pieces of the periosteum* were torn off, with *exfoliation of the bone* in 2. There were *periosteal defects following suppuration* in 5 cases, with *exfoliation of the bone* in 4. The *entire scalp was replaced in one piece* in 21 cases, in all but one of these there was total failure. In this case there was nearly complete healing after 98 days. *Left ear involved,* 12 cases; *right ear involved,* 11 cases; *both ears involved,* 2 cases; *ear involved, but which side not stated,* 1 case. *Retraction of the upper eyelids,* 9 cases. *Infection of the eye resulting in destruction,* 2. In practically every area grafted *small ulcerations have appeared* on the grafted area after the original healing. These ulcerations have been more or less resistant to treatment. *Cases grafted,* 57, with complete healing in 33 cases; *strips of the denuded scalp,* in combination with other grafts, being used in 2 of these cases. *Death occurred* in 8 cases, as follows: in 1839, 1 case; 1841, 1; 1863, 1; 1869, 1; 1873, 1; 1876, 1; 1878, 1; 1908, 1.

Complete scalping by other forces, 4 cases. *Males,* 1; *females,* 3. The *youngest* was 4 years and the *oldest* 60 years. *Age in decades:* 1 to 9 years, 2 cases; 30 to 39 years, 1; 60 to 69 years, 1. *Date of cases by decades:* 1840 to 1849, 1; 1900 to 1909, 3. *Loss of consciousness, shock,* and *hemorrhage* and *pain* were not stated in any of these cases. *Periosteal defects at time of accident,* 3 cases, in 1 of which there was *exfoliation of the bone. Exfoliation of the bone,* 1 case, the whole of the external table was exfoliated. *Complications: tetanus,* 1 case. *Treatment and results: cases grafted,* 1 case. *Type of graft used,* sliding plastic flaps 8 days after the accident, with recovery in 1 month. *Healing by cicatrization,* 3 cases. *Time of healing by cicatrization:* 5 months, 1; 6 months, 1; *time of healing not stated,* 1 case.

Haubold's case is the only one on record which was completely covered by plastic flaps from the surrounding hairy scalp, and this of course was due to the retraction of the wound and to the fact that only a portion of the scalp was removed.

INCOMPLETE SCALPING, 30 CASES.

Scalping by the claws of animals, 2 cases, both *males. Age,* 7 years in one case, the other an adult; both were scalped by the claws of bears. In the first case the patient was healed by cicatrization in 3 months, and hair grew here and there over the wound. In the other the flap was replaced but sloughed later. There were other wounds on the back, hip, and arm. The patient died 11 days after the accident.

Incomplete scalping in which the method of injury was not given, 4 cases. *Females,* 3; *age* not stated in 1. The *youngest* was 10 years and the *oldest* 58 years. No details were given in regard to *loss of consciousness, pain, hemorrhage, shock,* or *periosteal defects.* The *flap was replaced and sutured* in each case. There was sloughing of part of the flap and *exfoliation of the bone* in 1 case, with healing in 9 months. One case healed in 2 months; 1 in 1½ months; 1, failure of the flap and no result was given. *Complications:* erysipelas, 1 case; suppuration, 1 case.

Incomplete scalping by machinery, 10 cases. All *females.* The *youngest* was 10 years, the *oldest* 40 years. *Age in decades:* 10 to 19 years, 5 cases, 20 to 29 years, 1; 30 to 39 years, 1; 40 to 49 years, 1. *Age not stated,* 2. *Date of cases by decades:* 1860 to 1869, 1 case; 1870 to 1879, 1; 1880 to 1889, 1; 1890 to 1899, 4; 1900 to 1909, 3. There was *loss of consciousness* in 2 cases. *Shock,* slight, 1. *Hemorrhage,* 5, severe in 3, slight in 2. *Arteries tied* in 1 case. *Pain,* 2, slight in both. *Periosteal defects,* 4. *No exfoliation of the bone. Complications: left ear involved,* 3; *right ear involved,* 1. Left shoulder badly injured, 1. Badly lacerated wrist and contusions on thigh, 1. Infection, 1. Meningitis, 1. *Treatment and results:* The *flap was replaced* in each case, and healed in 6, sloughed entirely in 2; one of these cases was healed later by skin grafting. Sloughed more than half in 1, which was healed later by skin grafting. One case died within 24 hours. *Time of healing by grafting:* 2½ years, 1 case. Time not stated, 1. *Types of grafts used:* Thiersch, 1 case; autodermic Reverdin, 1. *Time of healing by replaced flaps:* 10 days, 1 case; 18 days, 1; 54 days, 1; 2 months, 1; time not stated, 2. *Death* occurred in 2 cases, 1 on the thirteenth day from meningitis; 1 case did not regain consciousness after the accident and died on the following day.

Incomplete scalping due to other forces, 14 cases. *Males,* 11; *females,* 3. The *youngest* was 8 years, the *oldest* 76 years. *Age in decades:* 1 to 9 years, 1; 10 to 19 years, 4; 20 to 29 years, 2; 30 to 39 years, 2; 70 to 79 years, 1. *Age not stated,* 4 cases. *Date of cases by decades:* 1830 to 1839, 4; 1860 to 1869, 2; 1870 to 1879, 1; 1880 to 1889, 3; 1890 to 1899, 3; 1900 to 1909, 1. There was *loss of consciousness* in 6 cases. *Shock,* severe, 1. *Hemorrhage,* 5 cases, 3 of which were severe, and 2 slight. *Immediate pain,* 3 cases; *subsequent pain,* 2. *Periosteal defects at time of accident,* 6 cases, with no *exfoliation of the bone. Complications:* infection, 3 cases; epileptiform attacks, 1; meningitis, 1; Colles's fracture, 1; baldness of the flap following the accident, 1. *Treatment and results:* the *flap was replaced* in 13 cases; patient refused treatment, 1 case. *Healed,* 10 cases; *result unknown,* 2 cases; *death,* 1 case. *Time of healing:* 4 days, 1 case; less than 6 days, 1; a few days, 1; 9 days, 1; 11 days, 1; 1 month, 1; 5 weeks, 1; time not stated, 4; *death occurred* on the twenty-fourth day from meningitis in 1 case; result unknown, 2 cases.

There are probably a great number of cases of incomplete scalping reported in the literature, but listed under lacerated wounds of the scalp, which are not included in our series.

SYMPTOMS.

There are a number of immediate symptoms which differ somewhat in intensity in incomplete and complete scalping, depending upon the extent of the injury, the method of causation, and the force by which it is inflicted.

Pain is rarely complained of at the time of the accident, and may be so slight that the loss of the scalp is not realized by the patient until the hand is placed on the head. It may become very severe within a few hours. This is especially marked during the dressings and may be of sufficient severity to require either a cocaine spray or a general anæsthetic, and lasts for an hour or two afterwards. The pain may continue several weeks, but as a rule then ceases entirely. Fortunately the subsequent pain is very slight in most of the cases, and the dressings cause little discomfort.

The hemorrhage may be severe enough to give rise to a marked temporary anæmia, but is usually very slight when we take into consideration the extent of the wound and the vascularity of the scalp. It is usually venous hemorrhage, as the external coat of the veins is very closely connected with the firm tissue of the subcutaneous layer, and thus the lumen is held open. The arteries, on the other hand, although somewhat adherent to the subcutaneous tissue, behave differently on account of the inequality of elasticity of the various coats. As the traction goes on, although it may be very rapid, the middle and internal coats give way first and retract, thus diminishing the calibre and partly blocking the lumen.

There is seldom serious collapse from hemorrhage, although death from hemorrhage is the only way simple avulsion can be immediately fatal. The anæmia due to the hemorrhage may persist and materially retard the treatment.

Sometimes in spite of the fact that there is little or no pain and no hemorrhage, there quickly follow varying degrees of shock and even complete collapse. On the other hand the patient may be so slightly affected that in some cases she has insisted on replacing the scalp and walking to her home, or to the hospital.

There is usually very profuse discharge from the granulating surface, which is often depleting to the general health of the patient. In the majority of cases the result of simple avulsion on the general condition is slight, but the danger comes from the complications which may follow.

COMPLICATIONS.

These may be divided into three groups. First, those which occur at the time of the accident; second, those which occur during the progress of the treatment; third, those which are due to cicatricial contraction.

Those in the first group are due to other forces than the simple traction which causes only the avulsion. The patient may be lifted and then dropped or thrown violently against some neighboring object. Some other portion of the body

may come in contact with the moving machinery, and thus various injuries result, such as fracture of the skull, fracture of the clavicle or rib, avulsion of the thumb, etc. This group of complications is not as usual as might be supposed, as in the majority of cases the scalping is the only injury.

Those in the second group are principally due to infection. These are fortunately much less frequent than they were before the days of aseptic and antiseptic surgery, although they still occasionally occur in spite of every precaution.

It was then the rule rather than the exception to have severe inflammation with fever and suppuration, lasting for months and followed by great weakness, loss of health, and degeneration of organs due to prolonged suppuration.

Erysipelas appeared sometimes more than once during the course of the treatment. Phlegmon and abscess, septicæmia and pyæmia were common. In some instances the infection extended into the interior of the skull through the emissary vessels, or through a defect following necrosis of the bone, causing meningitis, brain abscess, and other cerebral infections, which sooner or later resulted in death.

There may be necrosis of bone with exfoliation in those cases where the periosteum is torn, especially when the bone has become dry and the granulations have not covered it. The periosteum may be destroyed later by suppuration, and bone necrosis follow.

Occasionally there is secondary hemorrhage due to the ulceration of vessel walls following infection. Hemorrhage may take place from granulation capillaries when the head is lower than the body, and also when the blood-pressure is increased during the administration of an anæsthetic, or from nausea following anæsthesia.

Tetanus has developed in several cases, and mastoiditis also is an occasional complication. There have been symptoms of iodoform and carbolic poisoning following the too free or long-continued use of these drugs as dressings. An occasional septic pneumonia has also occurred.

Those in the third group are for the most part due to

cicatricial contraction and are often very severe. They cause hideous deformities due to ectropion of the upper eyelids and occasionally an eye is subsequently lost from infection. The upper eyelid is most often pulled up and out, the result being that the axis of the palpebral cleft is deviated, becoming oblique from top to bottom and from outside to inside, giving a Mongolian expression (Fig. 8). The contraction, on the other hand, may tend to draw up the surrounding soft parts, and thus make a smaller area to be covered. Occasionally the ears are somewhat displaced by the contraction. The worst contractions follow those cases where the scalp is torn off beginning from or including the eyebrows, and the principal effort of the surgeon should be to overcome this tendency by the application of suitable grafts over this area before the contraction begins to be serious. Aside from those already mentioned there are remarkably few bad consequences after the healing is complete.

There is occasionally quite marked sensitiveness to heat and cold, neuralgia, feeling of weight, headache, and vertigo.

PROGNOSIS.

Before the introduction of surgical cleanliness, Follin and Duplay made the statement that complete scalping was always terminated by death. To-day, since the antiseptic and aseptic era began, the prognosis as to life has been excellent. The utilization of skin grafting in the treatment of such wounds has also greatly influenced the results. There is little immediate danger from a simple scalping.

In incomplete scalping there is nearly always prompt healing when the flap is replaced and properly treated, although total sloughing of the pedunculated flap is reported in several instances.

In the complete variety one of the methods of skin transplantation is necessary to bring about the desired result within a reasonable time.

The severe infections, once so common, may now be almost eliminated by modern methods of treatment.

The unsightly deformities due to the retraction of the

eyelids can often be avoided by the early application of well-placed skin grafts.

The new scalp is never as stable as the original one, except when whole thickness grafts are successful, and often there is much trouble caused by ulceration on the unstable healing due to pressure of the wig or some slight injury or infection.

The sensation of grafted areas on the cranium extends slowly, and comes in from the periphery, as in other parts of the body, and not from the underlying tissues. Thus the greater part of the grafted area may remain anæsthetic for years. In no case reported has acute sensation been present further than 2.5 cm. from the normal skin, except in Cases I and II. This lack of sensation in several instances has been the cause of infection and ulceration; for example, one patient ran a hat pin through the grafted area without being aware of it, and infection followed. For this reason it is necessary to impress on the patient the great importance of carefully protecting the newly transplanted skin until it is capable of normal resistance.

TREATMENT.

Many ancient as well as modern authors, from Hippocrates to the present day, have written of scalp wounds, and definite rules have been formulated for their treatment. We have to deal, however, with a type of scalp wound which requires patience, much care, and special treatment.

THE TREATMENT OF INCOMPLETE SCALPING.—In cases of incomplete scalping where a pedicle remains, even though it is very small, the treatment in the majority of instances is comparatively simple, as the vitality of the flap is preserved to a considerable extent through the vessels in the pedicle, and by means of free anastomosis the blood supply is soon re-established. Success, however, is not always certain, as for instance in Gussenbauer's case there was slough of the entire scalp although the pedicle was 9 cm. wide. The richness of the pedicle supply depends largely on its size and location. All that is necessary, then, in addition to this blood supply, is absolute surgical cleanliness, with proper drainage and accu-

rate approximation of the wound edges with sutures. It is useless to go into a detailed account of the cleansing, as it only varies in its minor details with the individual surgeon. However, one or two points should be borne in mind. The denuded skull should be thoroughly protected from further contamination during the shaving and careful cleansing of the flap by means of sterile dressings wet with warm salt solution. Then after the flap is cleansed it should be wrapped in warm moist dressings and held out of the way, without twisting the pedicle, while a painstaking and thorough toilet of the wound and surrounding tissues is being made. No strong antiseptics should be used in this preparation, but a soft brush with soap and water and plentiful flushing with sterile water, boracic, or normal salt solution is all that is necessary.

A first dressing of silver foil and sterile gauze, secured by a snug bandage, will be found satisfactory, but many surgeons prefer a dressing of sterile gauze moistened with normal salt solution. As a rule the healing is complete within a few days, but in those instances where there is slough of a portion of the flap, the resulting granulating wound must be treated as seems best under the existing conditions. If the wound is of any considerable size, skin grafting may be advisable to hasten the healing.

THE TREATMENT OF COMPLETE SCALPING.—When a case of complete scalping is presented, the question at once arises as to the advisability of replacing the scalp. The scalp has been replaced in 21 cases, but that of Malherbe is the only one which has resulted even in partial success, and even this is doubtful, as LeJars, in "Urgent Surgery," vol. i, 1910, page 87, speaking of this case says: "The scalp died, but turned into a parchment-like covering which remained adherent to the cranium, and under which healing took place without complications."

When we consider the poor blood supply of the periosteum, it is easy to understand failures in replacing scalps, especially when we bear in mind the liability to infection.

The old method of allowing these wounds to heal by

cicatrization is no longer to be considered, as it is unsafe and requires so much time, and also gives an unstable result. Therefore it is necessary to obtain material with which to cover the wound by one of the methods of skin grafting.

Surface to be Grafted.—Whether to graft immediately or to wait until granulations have formed is a matter to be considered. Several cases have been successfully grafted at once or within a few hours after the accident, but the consensus of opinion is that it is safer to wait for a better blood supply.

I believe that there is little if any time gained by immediate skin grafting in these cases, although it is advisable to transplant strips of the torn off scalp. It is much better to wait until the wound is covered with healthy granulations before attempting to graft. If a fresh case came under my care, I should try to preserve at least a portion of the scalp, and apply it in strips when the conditions seemed favorable.

The grafts may be placed on undisturbed granulations or on granulations slightly rubbed with gauze sponges, or on the firm base after the granulations have been removed.

It is undoubtedly advantageous in cases of avulsion to place the grafts on undisturbed granulations, as there is no pain in the preparation of the surface; no loss of blood, which is an important point in cases already much depleted; little likelihood of blood or serum collecting under the grafts, and no danger of stirring up infection. It seems reasonable to believe that the capillary loops of undisturbed granulations are in better condition to immediately penetrate the graft than if these loops have been disturbed or curetted off and have to regenerate before they can penetrate and effectually nourish the newly transplanted skin. This regeneration takes about 24 hours, which means that considerable time is lost before the newly formed vascular loops are even ready to enter the grafts. This time is gained, therefore, by placing the grafts on undisturbed, healthy granulations.

Nature begins her attempts at healing by the formation of granulation tissue, which first appears at the margins of the

wound and along the line of the cranial sutures. These granulations spread to join other numerous similar smaller areas, which soon spring up over the surface of the periosteum, and finally cover the entire wound. Should there be a defect in the periosteum, granulations often cover the denuded bone, but sometimes there is exfoliation of the outer table due to necrosis, in which case the granulations spring from the diploe.

It is important to suture any rent in the periosteum if possible, but if there is a loss of substance, dress the uncovered bone with wet dressings, so that it will not dry out and become necrotic. A piece of rubber protective over the denuded bone will also keep the bone moist until the granulations have formed over it.

Stimulation of Growth of Granulation Tissue.—In some instances there is much difficulty in causing the granulations to grow on the periosteum satisfactorily, and as the success of every method of grafting in these cases depends on the healthy state of the granulations, it is of prime importance that the necessary condition be brought about as soon as possible. This result depends to a large extent upon the general health of the patient, therefore a vigorous building-up treatment should be inaugurated in addition to the local treatment.

Classification of Skin-Grafts.—In a general way grafts may be divided into *thin grafts,* where only a portion of the thickness of the skin is utilized, as obtained by the methods of Reverdin and Thiersch, and *thick grafts,* where the whole thickness of the skin is used. This latter division includes whole thickness sessile flaps and whole thickness pedunculated flaps.

Grafts may be further divided into *autodermic,* where the graft is obtained from the same individual; *isodermic,* where the graft is obtained from another individual of the same species, and *zoodermic,* where the graft is obtained from a lower species.

The Use of Isodermic Grafts.—There is much difference of opinion as to the advisability of utilizing isodermic grafts, and many surgeons insist that only autodermic grafts should

be used. Of course autodermic grafts are more likely to succeed. However, a study of the results obtained by means of isodermic grafts at the Johns Hopkins Hospital, and also my own experience with these grafts, have convinced me that both thin and thick isodermic grafts are well worth trying, and that very good lasting results may be secured if the grafts are obtained and transplanted with the proper technic.

Zoodermic Grafting.—Both thin and thick grafts have been tried on a number of cases of scalping, but with no permanent success. The skin of dogs, lambs, rabbits, and guinea pigs, etc., has been utilized, and while many of the grafts at first would apparently take, in the course of a few weeks they would be absorbed. I think that zoodermic grafts have a better chance of ultimate success in other regions of the body which are less exposed than the cranium.

Whether to cover the entire wound with grafts at one time is a matter to be determined by the individual surgeon. It has been done in one or two instances, but the majority of surgeons prefer to graft only a portion at a time, say a half or a third. There is no reason why the entire area should not be covered at one time with Thiersch grafts, but some difficulty might be encountered in securing enough whole thickness skin to cover an entirely denuded cranium at one time.

Method of Preparing Skin before Cutting Grafts.—A simple and satisfactory method of cleansing the skin before cutting the grafts is to shave the part selected, then scrub carefully with green soap and water. Rinse with sterile water, sponge with ether followed by alcohol. Then rinse thoroughly with sterile normal salt solution and dry with a sterile towel.

Method of Preparing Healthy Granulations to Receive Grafts.—On the day preceding the operation, remove all secretions and crusts. Wash thoroughly with sterile boric solution and dry. Paint with tincture of iodine and dress with balsam of Peru and castor oil, 2 to 6. Allow this dressing to remain in place until the time of operation. Then

remove it and wash the wound carefully with warm boric solution, or normal salt solution sponges, without causing bleeding. Follow this by an irrigation of normal salt solution and then dry carefully with sterile gauze.

Place several layers of dry gauze over the wound, and press them down firmly on the granulations, removing them only when the grafts are ready for application.

I will not take up the *technic of grafting,* as I have fully covered this matter in vol. xv, of the Johns Hopkins Hospital Reports.

Transplantation of Hair-bearing Skin.—In those cases in which the eyebrows have been torn off, small whole-thickness flaps of hairy skin from the pubis or any other hairy region, with a portion of the subcutaneous tissue, may be successfully transplanted to the eyebrow region and the hair will grow. Fine hair also grows on whole thickness flaps taken from the thigh. Enz says that hair grows at first on the transplanted pieces of scalp, but that it soon falls out. Lotheissen had a similar experience in transplanting skin from the pubic region. Burdel, on the other hand, found in his case that hair grew on the areas transplanted and did not fall out. I have successfully transplanted hair-bearing skin on other parts of the body, and later there was a vigorous growth of hair. Several attempts have been made to transplant single hairs including the sheath, but without success. No hair whatever will grow on those areas covered with Thiersch or Reverdin grafts, and this is easy to understand, as the hair-growing portion of the skin is not transplanted.

The Treatment of Ulceration of the Grafted Surface.—The treatment of small ulcers, which appear in the cicatricial tissue and here and there over the areas grafted with thin grafts, is sometimes very tedious and unsatisfactory. Where these ulcers are of any considerable size, say 1 cm. in diameter, much time can be saved by grafting with small deep grafts as soon as the granulating base is healthy. This healing will be more stable than on those ulcers which heal spontaneously, and I have not yet seen an instance in which the ulcer has broken down again after this treatment.

Another method which has given me satisfaction is the use of 8 per cent. scarlet red salve, made up in simple vaseline or in balsam of Peru ointment. By this means the epithelium seems to be stimulated and a good stable healing brought about. However, a combination of these two methods is probably the quickest and best. Apply the small deep grafts first to the untouched granulations, and dress with overlapping strips of protective. Then from 24 to 48 hours later remove the protective and dress with scarlet red ointment. This combination is also advantageous in hastening the healing of those whole thickness grafts which cast off some of the outer layers and are slow in "topping off."

Treatment of Complications.—No hard and fast rules can be laid down for the treatment of complications, but each must be taken in hand promptly.

All the modern advances in the treatment of infections with autogenous and stock vaccines, serums, etc., must be utilized in the severe cases, in addition to the local treatment.

Ectropion and similar deformities can be prevented by early and proper grafting, but should they occur, relief can only be obtained by a plastic operation or further grafting.

ANIMAL EXPERIMENTS.

Through the courtesy of Dr. Harvey Cushing I was able to carry out the experiments outlined below, in the Hunterian Laboratory of the Johns Hopkins Medical School.

Young animals between 3 and 12 months were used for these experiments. The scalps were shaved and then washed with soap and water, followed by alcohol and ether. Dry technic was employed throughout until the flaps were replaced. Ether anæsthesia was used in each experiment.

Experimental scalping on dogs presents a number of difficulties, especially in the after treatment. The great movability of the dog's scalp and the difficulty in immobilizing the replaced flap are factors to be considered, since absolute immobility is essential, in order that the blood supply may enter the flap within a reasonable time.

The constant scratching and rubbing, with the consequent

disarranging of the dressings and even of the flap itself, and the liability to infection must also be thought of. It is indeed fortunate that all of these troubles can be eliminated, to a large extent, in the treatment of the human. It is, therefore, hard to draw accurate conclusions from the experiments, and especially from those cases where the flap was totally removed.

SERIES I.—*Complete Removal of a Flap of the Scalp, with Replacement within 20 Minutes; Résumé.*—Thirteen experiments. The flap removed varied between 1.25 and 6 cm. in diameter. In 11 the flap included all the tissues down to the periosteum and fascia of the temporal muscles. In 2 the fascia of the temporal muscles was removed and the flap was placed on muscle tissue. The superficial muscles were removed from the flap in 10, and were allowed to remain in 3. Four flaps were replaced immediately. Five flaps were replaced after 10 minutes. Two flaps were replaced after 15 minutes. Two flaps were replaced after 20 minutes. All were sutured into position. Four were button-holed and drained. Nine were button-holed but not drained.

Dressings.—Four were dressed with balsam of Peru, 2 parts, and castor oil, 6 parts, on gauze, and bandaged. Three were anointed with vaseline and exposed to the air without other dressing. Two were exposed to the air without dressing. One was dressed with moist salt gauze and protective. Three were dressed with amberine.[4]

Result.—Total failure of all. In 9 of these the flap dried out, and the four which were dressed with moist dressings macerated.

On removal of the flap in every instance the wound was covered with healthy granulations, even over the periosteum. The wounds healed promptly by cicatrization, leaving a smooth scar which was markedly smaller than the original wound, and in no case was there any noticeable retraction of the eyebrows.

SERIES II.—*Complete Removal of a Flap of the Scalp, with Replacement 24 and 48 Hours Later; Résumé.*—Six experiments. The flaps removed varied between 2 and 3.5 cm. in diameter. They included all the tissues down to the periosteum and fascia of the deep muscles. All were kept in sterile jars containing a moist salt sponge. Four were replaced after 48 hours, and 2 were replaced after 24 hours. The granulations were stimulated by fitting several layers of dry gauze into the defects and covering with overlapping strips of protective. All the flaps were sutured into position and all were button-holed.

Dressings.—Four were dressed with overlapping strips of protective and moist salt gauze, and 2 were exposed to the air without dressing.

Result.—There was total failure in all. Four flaps macerated and sloughed. Two dried out. The healing was as described in Series I.

SERIES III.—*Flap Separated from the Surrounding Skin, but not*

[4] Amberine is said to be a mixture of wax, paraffine, and rosin, which can be applied very hot without burning the tissues. It acts as a moist dressing, and it is claimed that it keeps its heat for a considerable time.

Lifted from Its Bed; Résumé.—Four experiments. In this series an incision was made around an area of scalp about 6 cm. in diameter down to the periosteum and temporal fascia. This incision cut off entirely the circulation except from immediately below the flap. All the flaps were sutured and freely scarified.

Dressings.—Three were anointed with vaseline and exposed to the air, and 1 was exposed to the air without vaseline.

Result.—In all there was puffiness of the flap for a few days. A small portion of one flap sloughed, otherwise there was *per primam* healing in all. The final result in all showed an area of normal appearing scalp covered by a full growth of hair. This was surrounded by a slight scar which was freely movable with the rest of the scalp.

SERIES IV.—*Pedunculated Flaps; Résumé.*—Four experiments. The flaps and pedicles varied in size as follows: 5x7 cm. with a pedicle 1.25 cm. broad; 6 cm. in diameter with pedicle 1.5 cm. broad; 6 cm. in diameter with a pedicle 8 mm. broad; 5 cm. in diameter with a pedicle 6 mm. broad. The incision was carried down to the periosteum and fascia of the temporal muscles. Each flap was lifted and held away from its bed for from 10 to 20 minutes. All were replaced without removing the superficial muscles and all were sutured and button-holed. Three were drained with protective wicks through button-holes in the adjacent skin, and the fourth was not drained.

Dressings.—All were anointed with vaseline and exposed to the air.

Result.—There was thickening of all the flaps for the first few days. There was *per primam* healing in each case with no slough. The result was a freely movable flap of normal appearance and with a normal growth of hair. The flaps were all cut as in Fig. 9.

CONCLUSIONS.

Series I seem to show that it is useless to replace a totally removed area of scalp and expect it to heal in its bed, even if of small size. Also that granulations appear to grow well on the periosteum under the re-applied flap. For this reason alone, then, the scalp might be replaced *in toto* after proper cleansing and free drainage, and if carefully watched and removed at the proper time would not cause infection and might stimulate the growth of granulations on the pericranium.

In spite of the discouraging results in Series II, I believe that this is a procedure which promises well, as whole thickness grafts can be preserved so satisfactorily that a portion of an avulsed scalp could easily be preserved and applied after the granulations had formed.

Series III indicate that there is sufficient blood supply from below to preserve a flap, which is completely isolated from

the surrounding circulation, until the normal circulation is re-established.

Series IV show that comparatively large areas of scalp with small pedicles may be successfully replaced, and the final condition of the replaced flap is practically that of the normal scalp in movability, in appearance, and in its ability to grow hair.

The scarification of the flap is important, as the openings allow the escape of the blood, which easily enters the flap but cannot leave it promptly until the circulation is re-established, and thus prevents congestion. It also allows free drainage of any blood or serum from beneath the flap.

COMMENTS.

There are two clinical varieties of scalping, incomplete and complete. In this paper we have considered 30 cases of incomplete scalping, 91 cases of complete scalping, and in addition 8 cases due to burns and 1 case where the hair was torn out without injury to the scalp. Ninety-one of these accidents were caused by machinery, and all but one were females.

The scalp is caught between two forces which oppose each other. The line of separation is as a rule at the junction of the scalp with the skin of the face and neck.

The amount avulsed varies with the amount of hair caught and with the direction and intensity of the force. The direction of the force is usually obliquely, from front to back, with the superciliary ridges acting as the cutting instrument. The separation takes place in the loose subaponeurotic layer, but now and then the periosteum is removed to a greater or less extent.

The symptoms differ somewhat in intensity in incomplete and complete scalping, depending upon the extent of the injury, the method of causation, and the force by which it is inflicted.

The pain is usually slight. The hemorrhage may be severe, although it is generally of short duration. Shock may be profound, but in the majority of cases the direct result of simple avulsion on the general condition is slight. The danger comes from the complications, which may be divided into

three groups: first, those which occur at the time of the accident; second, those which occur during the progress of the treatment; third, those which are due to cicatricial contraction.

The prognosis as to life since the advent of antisepsis and asepsis has been excellent. The utilization of skin grafting in the treatment of these wounds has also greatly influenced the results.

The treatment of cases of scalping requires patience and much care, and varies markedly in the incomplete and complete varieties.

In cases of incomplete scalping, all that is necessary in the majority of cases, in addition to the pedicle supply, is absolute surgical cleanliness, with free drainage and accurate approximation of the wound edges with sutures, and properly chosen dressings.

The treatment of complete scalping is a much more difficult problem. Both clinical and experimental evidence show that it is useless to replace the scalp *in toto* and expect it to heal, but strips of the scalp may be successfully applied on the periosteum along the wound edges, as immediate whole thickness grafts. I believe that it would be well worth trying to preserve a portion of the avulsed scalp to be applied when the granulations are well started.

The scalp may be replaced, sutured, and drained after very thorough cleansing, and used as a dressing, and if carefully watched and removed at the proper time will not cause infection. I have noticed in experimental work on the scalp that granulations seem to grow more readily on the pericranium under a flap, which subsequently sloughed, than under any other dressing.

As the old method of allowing these wounds to heal by cicatrization is no longer to be thought of, one of the methods of skin grafting is necessary..

Immediate grafting has been successful in a few cases, but it is better to wait until the granulations are in good condition. The periosteal blood supply is very poor and granulations form on it slowly, and the chance of success on a large area of uncovered periosteum is small.

Grafts may be placed on scraped or on undisturbed granulations, and I have found that any type of graft will take as satisfactorily, if not more so, on a healthy undisturbed granulating area than on a fresh wound.

The health of the patient is important and the success of every method of grafting depends upon the healthy condition of the granulations.

Grafts may, in a general way, be divided into *thin grafts,* where only a portion of the thickness of the skin is used, and *thick grafts,* where the whole thickness is used. These may be either *autodermic, isodermic* or *zoodermic.* Autodermic grafts are of course the most likely to succeed, but my own experience has shown me that isodermic grafts are well worth trying.

One or two wounds have been covered with grafts at one time, but usually only a portion is covered at a time.

It is difficult to immobilize grafts on a rounded surface like the cranium, but this has been overcome by the use of rubber impregnated mesh, as can be seen in Fig. 10.

Grafts obtained by Reverdin's method have been used in several cases, but a great deal of time is consumed and the final healing is unstable when compared to the other methods, and there is more likelihood of contraction.

Since 1889 the majority of these wounds have been covered with grafts obtained by the method of Thiersch, and this type of graft is chosen by most surgeons, and undoubtedly gives quicker and better lasting results than can be obtained by the small epidermic grafts of Reverdin.

Whole thickness grafts have been used in conjunction with thin grafts on a few cases, but my own case is the only one, as far as I can ascertain, which has been completely healed by means of whole thickness grafts. There is no doubt but that the healing from whole thickness grafts is the most stable, as is shown in the comparison of the results in Cases I and II, and it seems to me that this method should be employed in the treatment of these wounds.

THE RESPONSIBILITY OF THE TONSIL IN TUBERCULOUS ADENITIS.

BY FRANK S. MATHEWS, M.D.,

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To attempt to prove that the gland at the angle of the jaw may be infected with tuberculosis by way of the tonsil with which it is in such immediate anatomical and physiological relation would seem a demonstration of the obvious. No one is likely to dispute it, but when we ask whether the tonsil is the uniform, the occasional, or a rare source of cervical adenitis, we may expect widely different opinions.

For its frequent etiological relationship we have the following: Pathological conditions are frequent in children in both tonsils and lymph-nodes. When the tonsil is inflamed from any cause the tonsillar nodes at the angle of the jaw are the first to enlarge. One familiar with the early stages of tuberculous adenitis in children will agree that in at least 90 per cent. of cases the first nodes to enlarge are these same tonsillar nodes. Lymphatic anastomosis being very free, this does not rule out the possibility of infection of these nodes from a back tooth, the pharynx or the nasopharyngeal adenoids. Later in life infection of both tonsil and lymph-nodes is less common. Wood, of Philadelphia, says on the basis of personal observations, that the tonsils of consumptives show evidence of tuberculosis in the vast majority of cases, though the rest of mouth, nose, and pharynx does not. Dr. A. M. Shrady, with a very long experience at the Seton Hospital for Tuberculosis says it is a rare occurrence for consumptives to develop clinical tuberculosis of the tonsil and that they usually die without clinical signs of infection of neck nodes. On the other hand the infrequency of clinical tonsillar tuberculosis and hitherto the almost uniform failure to demonstrate it microscopically have made some question the etiological importance

of the tonsil in cervical tuberculosis. Other avenues of infection are by no means wanting, such as gums, nose, and pharynx, and even the skin of the face, lips, and scalp. In the past ten years we have seen probably 25 cases of tuberculous femoral adenitis result from scratches on the foot. One child under six months of age had a tuberculous inguinal bubo following a scratch with a diaper pin at the base of the penis. These cases are mentioned simply to show that almost any part of the body's surface may admit the bacillus. The writer submits the results of the examination of sixty-five whole tonsils recently removed. These can be considered in three groups:

1. *Fifty-seven tonsils removed for a variety of reasons from children and embracing all types of tonsils.* In none of these patients was there reason to suspect tuberculosis in the neck or other part of the body. None showed tuberculosis on microscopic examination in the tonsil, *i.e.*, there was no accidental discovery of tubercle in a tonsil where it was not suspected. This confirms the experience of others. Hodenpyl examined several hundred tonsils without finding any tuberculous. Hurd quotes Wright as having examined 60 unselected specimens without finding tubercle. Judd, of Rochester, says that at the Mayo's Clinic only one or two tuberculous tonsils have been found among some hundreds of tonsils sectioned. In conversation one frequently hears it said as a piece of common knowledge that tonsils removed for all causes are found tuberculous in 5 to 10 per cent. of cases. I am unable to find who said it first and feel certain that it does not approximate the truth. With the uniform result of examinations by Hodenpyl, Wright, the Rochester Clinic and myself we feel safe in asserting that one is not likely to find the tonsil harboring the tubercle bacillus without other manifestations of tuberculosis in the body.

2. *Five tonsils showing well-defined tuberculous lesions and all taken from children with recent tuberculous cervical adenitis.*

CASE I.—A small collection of nodes at angle of left side of jaw, largest hickory-nut sized. Left tonsil small. In it, several

discrete scattered tubercles, few giant cells, just a suspicion of central necrosis. A couple of tubercles located in the capsule of the tonsil.

CASE II.—Boy at Sea Breeze Hospital for Tuberculosis. Adenitis has not been operated on. Has widely distributed enlarged nodes in both sides of neck. Tonsils are peppered with discrete miliary tubercles both near mouth surface and capsule. No giant cells or necrosis.

CASE III.—Age three years. A collar of enlarged nodes in both sides of neck. Seem recent. Von Pirquet positive. Tonsil quite small. Small area in one tonsil shows giant cells with peripheral nuclei and poorly defined epithelioid tubercles. After removal of tonsils the glandular enlargement partly subsided and child removed from hospital without operation upon the neck.

CASE IV.—Already reported in ANNALS OF SURGERY, April, 1910, p. 577. The enlargement of neck nodes followed a tonsillotomy. Discrete typical miliary tubercles found in tonsillar stumps.

CASE V.—Child, age eight years. A few soft glands at angle of jaw found to be tuberculous. The tonsil on the same side as the nodes showed many typical miliary tubercles. The enlargement of nodes was recent.

3. *Cases with tuberculous glands in neck but without tuberculosis in tonsil.*

CASE VI.—Child, age three. Glands in right side of neck of one month duration. Von Pirquet positive. The largest node is the tonsillar one, but the first one to enlarge was in front of the submaxillary salivary gland and it was the only gland at operation which had gone to the stage of suppuration. Tonsils, small, appear normal and no tuberculous lesions found in them. In this case it would seem likely from location of swelling that infection took place through lip, gum, or floor of the mouth.

CASE VII.—Child. Tonsillar nodes enlarged. Also a large soft node in the substance of the parotid gland just in front of external auditory canal. Von Pirquet positive. Nodes proved tuberculous. Tonsil without tuberculosis. The clinical evidence would suggest that this was a case of scalp infection as the most advanced tuberculous lesion was in a node well up in the parotid gland.

CASE VIII.—Two good-sized tonsils not found to be tuberculous. Von Pirquet positive. A collection of nodes in right tonsillar group of several months' standing proved to be tuberculous. In this case clinical evidence suggested tonsillar origin.

As illustrating the probability with which we can infer the point of infection from the location of the first involved node, we may mention the following case: A child, aged four, had tuberculous nodes on the right side in the tonsillar and submaxillary region. A submaxillary node was suppurating. There was a red spot on the upper gum, at the insertion of the second incisor tooth, about one-fourth inch in diameter. This little piece of gum was removed at the same time as the nodes and showed typical tuberculous lesions. This is the only case in which we have demonstrated a tuberculous gingivitis as the starting point for tuberculous adenitis. In this case the tonsils appeared normal and were not removed.

There is an impression that the tubercle bacillus may penetrate the tonsil without producing any manifestations of its presence and be carried through it to the neck nodes. So far as I know, the only basis for the belief is one experiment by Wood of Philadelphia on a pig. He rubbed tubercle bacilli on the tonsil, killed the pig later and identified bacilli in the cervical glands only—not in the tonsil.

To sum up, 57 tonsils of patients not clinically tuberculous show no tuberculous lesions. Of 8 patients with cervical adenitis the tonsils are tuberculous in five. In two there is evidence of other than tonsillar origin for the infection. In one the adenitis was of long standing and may have been extratonsillar in origin or slight tonsillar lesions may have escaped observation.

These results closely parallel those of Hurd. In an examination of 11 tonsils from patients with tuberculous nodes he found tuberculosis in the tonsil 8 times. In an examination of 13 tonsils of persons with slightly enlarged neck nodes, not believed from clinical evidence to be tuberculous, only one tonsil showed tubercle. In cases then where there is clinical evidence that the tonsil is responsible for a tuberculous adenitis,

both Hurd and myself have as a rule found tuberculous lesions in the tonsil.

CHARACTER OF TONSILLAR TUBERCULOSIS.

Hurd has said that tuberculosis is to be found in the small buried tonsils, not the large soft elevated ones. We may put it in another way and say tuberculosis does not greatly enlarge the tonsil. In none of our five have the tonsils been considerably enlarged. The lesions as seen by the microscope have shown considerable variation in type. For instance, giant cells are in some few, in others abundant. In general we may say that the lesions are scattered rather than confluent, ulceration was never present and there was never more than a suggestion of central necrosis. In other words, we see the early or cellular type of lesion rather than the late fibrous and necrotic. The tubercles have been found both superficial and deep—in one case even in the capsule.

With a recognition of the frequency of tonsillar infection we shall probably more frequently remove the tonsil in cases of cervical adenitis than has been done in the past with the idea of avoiding reinfection of neck nodes. That we have been able to cure so large a per cent. of gland cases without removing the tonsil is simply another illustration, if one be needed, that we do not cure surgical tuberculosis by removing every single bacillus and lesion but by reducing the load of infection with which the body must contend.

If the tonsils and nodes are both to be removed, it would not seem wise to attempt both at one sitting. Which shall be done first will probably have to be decided on the merits of each case. We have seen the nodes largely subside on removal of the tonsils alone; in other cases the extensive involvement of such nodes makes their removal much more important than that of the tonsil.

The material for this paper has mainly come from St. Mary's Hospital for Children. The pathological work has been done at the Laboratory of Surgical Pathology of Columbia University through the kindness of Dr. W. C. Clarke.

TREATMENT OF TUBERCULOUS GLANDS OF THE NECK.*

A STUDY OF 649 OPERATED CASES.

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TREATMENT of tuberculous glands of the neck by excision dates from the time of Galen, although the first systematic dissections were probably done by Billroth in 1870 and by Rushton Parker and others in 1871.

Formerly, glandular tuberculosis of the neck was supposed to be an expression of general glandular infection, and it was believed that the infection travelled upward from a focus at some point inside the chest. Until the appearance of the comparatively recent study of the anatomy of the lymphatic system by Sappy, Leaf, Poirier, and Cuneo, our knowledge of the source of infection and the avenues travelled by it was very meagre.

There are approximately 800 glands in the entire human body, and nearly 300 of these lie within the tissues of the neck. The glands in this region are the first to appear in the embryo. Placed at the juncture of the head and neck are several groups of glands forming a kind of "glandular collar." This collar is composed of:

1. Suboccipital group, whose afferent vessels drain the occipital portion of the scalp; and efferent vessels which pass to the substernomastoid glands.

2. Mastoid group, which is composed of two or three glands receiving drainage from the temporal region of the scalp and ear, and with efferent vessels to the substernomastoid glands.

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* Read before the Section on Surgery, New York Academy of Medicine, May 19, 1910.

3. Parotid glands. These glands are again divided into several groups lying in different relations to the parotid salivary gland. There are from ten to twenty glands in this group; some lying superficially, some within the parotid, and a separate group lying between the parotid and pharynx. The afferent vessels to these glands come from the anterior part of the scalp, ear, eyelids, root of the nose, nasal fossa, and pharynx, and the efferent vessels pass into the deep cervical chain.

4. The submaxillary glands, three to six in number, lie along the lower border of the submaxillary bone. This group drains the upper and lower lip, cheek, nose, side of the tongue, and gums, and empties into the deep cervical chain.

5. Submental glands; a small group lying between the anterior bellies of the digastric muscles receiving afferents from the lower lip, floor of the mouth, and tip of the tongue, and sending efferents to the submaxillary glands.

6. Retropharyngeal glands. These glands receive vessels from the nasopharynx and drain to the deep cervical chain.

It will be seen that this glandular collar, composed of the six groups of glands, drains the entire scalp, skin, and mucous membrane of the head and face, and that each group sends its drainage to the deep cervical chain. There are no lymphatic vessels passing upward or communicating at any point within the skull.

The descending cervical chain, composed of the glands lying anterior and posterior to the internal jugular vein, and also of those lying in the supraclavicular region together with the secondary groups, may best be considered in a pathologic or surgical sense as one large group. The deep groups are each made up of a number of large glands. In the upper half of the neck they lie almost entirely behind the sternomastoid muscle, while in the lower division they lie opposite the posterior border and in the supraclavicular triangle. The chain extends from the tip of the mastoid process to the juncture of the internal jugular and subclavian veins. The afferent vessels to this chain are those coming from the groups making up the

cervical collar, and also several vessels passing directly to the deep glands from the scalp, tongue, palate, œsophagus, and thyroid. The vessels leading from these groups (deep chain-subclavicular-supraclavicular) unite on either side of the neck into one or two large lymphatic vessels called the *jugular trunks;* and these in turn empty on the right side into the internal jugular or subclavian veins, and on the left side directly into the thoracic chyle duct.

The glandular system in the neck terminates on either side in these large lymphatic vessels and has no direct communication with the lymphatic system in the thorax. Poirier and Cuneo, speaking of the afferent vessels of the supraclavicular group, say: "On the other hand these glands receive no vessels coming from the mediastinal glands. Cases of adenitis following mediastinal or abdominal neoplasms can only be explained by a retrograde thrombosis of the afferent vessels of these supraclavicular glands."

To me it seems very important that we should appreciate this point. A great deal of the incomplete and half-hearted work done in removing these glands has been due to the conviction that the diseased condition extended down into the mediastinal glands. From a more thorough study of the anatomy of this region, we now know that direct extension from the cervical glands into the mediastinal glands is impossible, and, therefore, that inflammations and neoplasms affecting the cervical lymphatics are *local* until they pass into the general circulation.

It is a fact generally accepted that the best treatment of accessible, tuberculous lesions, when they are still local, is that of excision. We know that in cases of tuberculosis of one kidney a very high percentage can be cured by removal. A similar process in almost any of the abdominal viscera, if diagnosed before too extensive, can be excised, and in the large majority of instances no further trouble will occur. The same is true of tuberculosis of the joints, epididymis, etc.

We are seldom able to positively demonstrate the exact avenue of the infection. Occasionally we may find the bacilli

in a decayed tooth, tonsil, or lupus area, but more often the point of invasion cannot be found. It has been shown, experimentally, that cultures of tubercle bacilli swabbed over the surface of the tonsil may leave no trace of their passing through that organ, but will invade the glands draining the tonsil. In our cases we were seldom able to trace back to the source of entrance. Examination of several hundred tonsils showed tubercles in much less than 1 per cent. In 1000 cases, 2.3 per cent. had positive tuberculous lesions.

From the histories of our cases of tuberculous glands, we find that in 80 per cent. the first enlargement was beneath the upper end of the sternomastoid muscle; in 18 per cent. the first noticeable enlargement was in the submaxillary, submental, or parotid regions. In four cases the first cervical gland to enlarge was in the supraclavicular group. In each of these four cases the axillary glands were also involved; the infection having presumably entered through an abrasion of the finger or hand. Several cases followed closely upon suppurating otitis media.

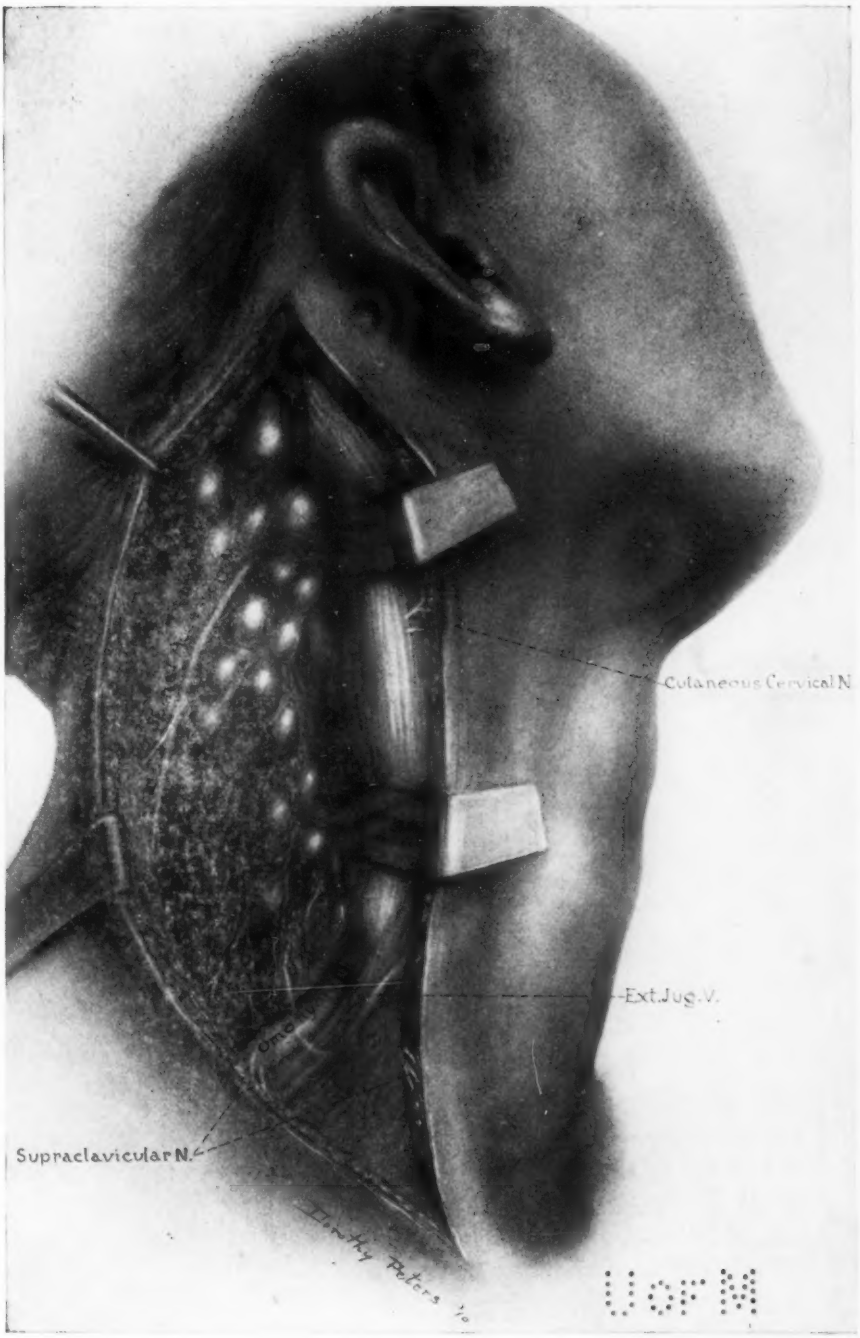
Indications for Operation.—If we were to make a routine examination of a great number of children between the ages of four and ten, we would find in the majority of them varying degrees of enlargement of the glands. The pathologic changes in these glands, formerly called *scrofulous,* are in part simple hyperplasia, in part tuberculosis. There is no differential diagnostic criterion of the initial stage of glandular tuberculosis. The tissues in these glands predispose and invite tuberculous infection. In this particular type of case our method of treatment has been as follows: First clear the throat of adenoid tissues and tonsils and give such attention as is necessary to the teeth and nose. Assisted by tonics, especially syrup of the iodide of iron, and with out-door living, this treatment has been sufficient to cure most of these cases. The cases that have been perfectly cured seem to be of the hyperplastic type, or, at least, to have been only to a slight degree invaded by the tubercle bacillus. We have occasionally seen a child with caseating nodes. Such cases require, in addition to the above treatment, removal of the infected nodes and drainage. If the

glands still continue to enlarge and other glands become involved, it will be necessary to do a complete excision to effect a cure. Most of the patients upon whom we have done a complete excision of the glands have been over fifteen years of age; 18 in 649 cases were under ten years. In the presence of a discharging sinus, it does not appear advisable to excise the glands; we have usually curetted and treated by swabbing with equal parts of tincture of iodine and carbolic acid. As soon as the sinus heals, a radical operation can safely be done if necessary.

Pulmonary invasion is not necessarily a contraindication to operation upon tuberculous glands of the neck. In ten instances we have operated upon patients who showed tubercle bacilli in the sputum. Nine of them were greatly improved and several of them were apparently cured by the operation. One developed an acute diffuse tuberculosis after the operation.

The chief objection to radical excision of glands of the neck is the resulting scar. Various incisions have been described and used. At one time the removal of the glands through many separate incisions was recommended. We have found that if we follow the natural creases in the neck and keep the incision as nearly as possible transverse, as suggested by Dowd, we can remove the gland-bearing fascia in one piece with very little scar or deformity resulting. The incision begins a little below and behind the mastoid process, extends straight down along the outer edge of the trapezius muscle, and then curves forward a little below the middle of the neck, and terminates at the juncture of the sternomastoid muscle and clavicle. Through this incision we are able to remove all of the deep descending chain, including the supraclavicular, the anterior, and the posterior groups. If the submaxillary and the submental groups are involved, a second incision running parallel to the lower jaw, two finger breadths below the lower border, will expose the areas and avoid any important structures, *e.g.*, the lower branches of the seventh nerve. In order to prevent the formation of a wide, ugly scar, it is very essential that we turn back the platysma muscle and the skin

FIG. 1.

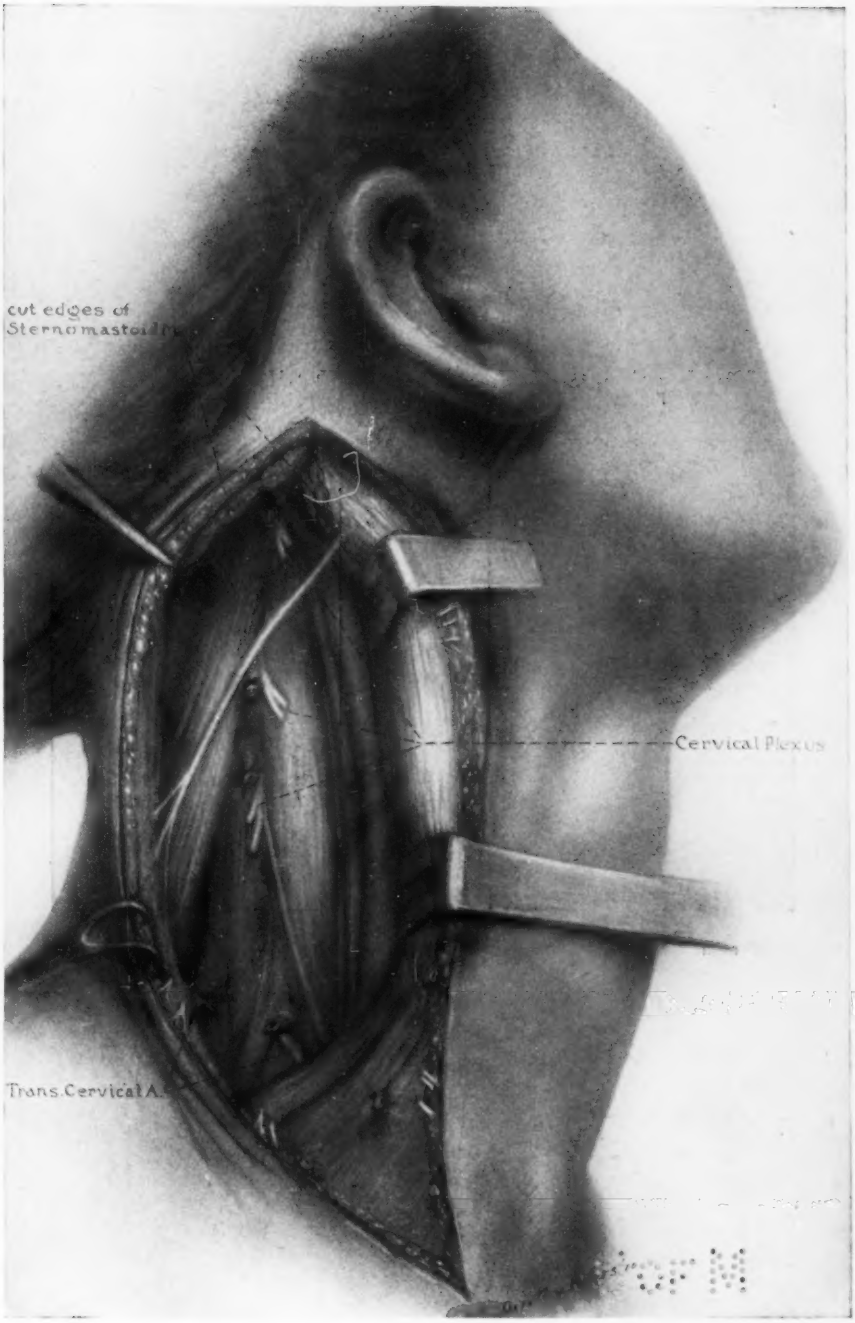


Showing the skin and platysma dissected forward and backward. Retractors under posterior border of sternomastoid, exposing glands lying in gland-bearing fascia. The omohyoid marks the lower angle of the dissection, and the mastoid process, the upper. The spinal accessory nerve is partly dissected from among the glands.

FIG. 2.

Showing fascia dissected from the lower angle. Internal jugular vein shown lying beneath the sternomastoid muscle. The phrenic nerve, lying on the scalenus anticus muscle and branching from the cervical plexus, is exposed.

FIG. 3.



Shows dissection completed. The spinal accessory nerve passes diagonally across from the upper part of the sternomastoid muscle to the inner surface of trapezius.

FIG. 4.

Photograph taken nine days after operation.

FIG. 5.

Photograph taken nine days after operation.

FIG. 6.

Photograph taken about two years after operation.

FIG. 7.

Photograph taken about two years after operation.

FIG. 8.

FIG. 9.

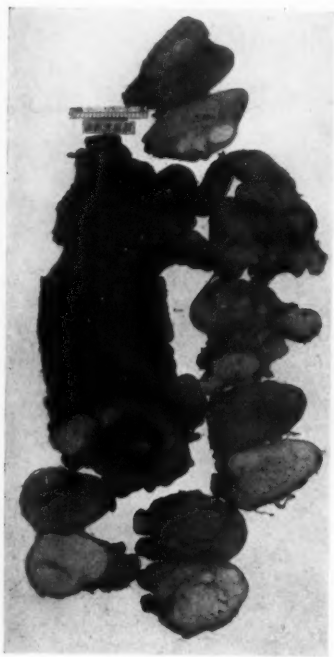


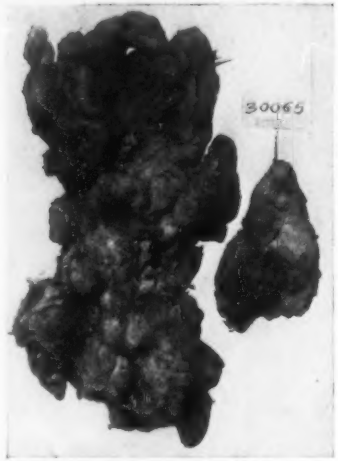
FIG. 10.

Figs. 8–10.—Photographs of tuberculous glands after excision.

Fig. 11.

Fig. 12.

Fig. 13.



Figs. 11–13.—Photographs of tuberculous glands after excision.

in each flap. It is also important that the cut edges in the platysma muscle be sewed together before closing the skin. If these cut edges are allowed to retract, the separation will favor the division of the skin scar. In the past it has not been unusual to see a scar on the neck half an inch to one inch in width (Figs 4 and 5).

It is our custom to drain these cases through a stab incision; this allows the large incision to heal primarily, and we believe this procedure of valuable aid in getting a good scar. The spinal accessory nerve is the only superficial structure that it is necessary to avoid in operating. In many cases the first gland to break down will be the one beneath the spinal accessory as it comes out of the sternomastoid muscle. In several instances we have known the nerve to be cut by simply lancing this broken-down gland. Usually the nerve will be readily found coming out of the sternomastoid muscle one-half inch above the superficial sensory nerves, or it may be identified as it passes into the outer border of the trapezius at the top of the supraclavicular triangle (Fig. 1). If the nerve is accidentally cut it can be sutured at once. It will unite and generally functionate well. If the ends of the nerve are allowed to retract, the deformity will cause a drooping shoulder and an atrophy of the trapezius muscle, which is unsightly and also hampers the use of the arm and shoulder to a considerable degree. We have injured and sutured this nerve on several occasions with no deformity resulting.

In a study of the anatomy of the lymphatics, we observe that tuberculosis invading these glands is likely to be a local process and not an indication of general infection. The entire chain of glands beginning at the subclavian vein and running back to the mastoid process can be removed in one piece without injuring a single important structure. If we consider the glands lying in the cellulo-adipose tissue (gland-bearing fascia) in the neck as a single organ, and treat the mass in a manner similar to that employed in tuberculosis of other organs, our results will be just as good and we will have done as much for the patient as though we had taken out a tuberculous kidney or removed a tuberculous cæcum.

Some years ago it was customary to expect all tuberculous glands to recur. Lymphatic glands and vessels are anatomical structures, and if they are removed we believe are no more likely to recur than a finger is likely to regenerate after it has been amputated. Leaf is alone, I think, in believing that a lymphatic gland will redevelop between the two open ends of lymphatic vessels. In our own cases, we are convinced that the glands which appeared after operation were glands which had not been removed.

During the past fifteen years we have performed 668 operations for complete excision of glands of the neck, 62 operations for partial excisions and curetting, and 24 excisions of tuberculous glands in the axilla in cases which also had tuberculous cervical glands. In all there were 649 patients operated upon on one side at a time. Of these, 19 have since died of pulmonary tuberculosis, and 9 have died of tuberculous lesions elsewhere. Ten of the patients had pulmonary tuberculosis at the time of operation.

In operating upon these cases, it has been our effort to do a radical and thorough excision of the groups involved. Having made the incision from the mastoid to the clavicle, we reflect the skin and platysma well forward and backward. We do not cut the sternomastoid, except a few posterior fibres of its upper attachment on the mastoid process. The entire posterior border of this muscle is freed and the fascia dissected from it. The dissection is started at the lower angle underneath the clavicular attachment. The omohyoid pulley is exposed and this is the lowest point of the dissection. The glands are all left together in the fascia as much as possible (Fig. 2). In some cases the gland-bearing fascia can be dissected with gauze or the finger; at other times, especially if the X-ray has previously been employed, or if considerable resistance has developed, the dense fibrous tissue will necessitate sharp dissection. In freeing the edge of the sternomastoid muscle from below, up about half way we come to the superficial cervical nerves, some of the branches of which turn over and across the muscle. These are purely sensory nerves and

it is best to sever them and get a good exposure. A numbness which persists for some time occurs after cutting these nerves. One-half to one inch above the sensory nerves the spinal accessory emerges from the sternomastoid muscle and passes obliquely downward and outward superficially through the fascia to the trapezius. In carrying the fascia upward, we should, if possible, save the cervical fascia covering the brachial plexus. Traumatism of this plexus will frequently cause considerable suffering. The thoracic chyle duct as it enters the vein should be avoided. It is not uncommon to see the chyle duct on the right side. We have injured this duct during operation in about ten cases; in several instances it healed without causing trouble. In three cases the chyle drained profusely for several weeks and the patients became greatly emaciated. One of them lost 60 pounds; the duct eventually closed, however. All the patients made a good recovery. When the spinal accessory nerve is encountered, it should be dissected free from the fascia and held back while the fascia and glands are turned underneath it. As soon as the internal jugular vein is exposed, it is best to partially occlude its lumen in the lower angle by a gauze pack. This will keep the vein full and prevent sucking of air in case the vein is torn. On several occasions we have heard air sucking into the vein, but have seen no bad results from it. The dissection along the entire jugular vein is sometimes tedious, but we have sacrificed the vein in tuberculous cases in only two instances. Some care should be taken to avoid the phrenic nerve lying on the anterior scalenus muscle. The fascia will lead us directly to the styloid and mastoid. Lymphatic glands within the parotid should be shelled out in a manner that will not interfere in any way with the branches of the seventh nerve. Having completed the dissection, if caseous material has soiled the wound, we mop it out with tincture of iodine well diluted with water; or as suggested by Von Eiselsberg, the entire wound may be mopped for an instant with boiling water. We have never seen any sort of an infection following the spilling of caseous material on the fasciæ (Fig. 3).

Drainage should be provided through a stab incision; we use, preferably, a small rubber tube split spirally. This drain is for the purpose of withdrawing serum and is removed in from 24 to 48 hours. The platysma muscle is carefully sutured with fine catgut, and the skin edges approximated by a subcuticular suture approximating as much of the cut of the skin as possible, giving the appearance of a ridge. In a few days this will smooth down to a line-scar (Figs. 6 and 7). A rather small, snugly fitting gauze dressing is used. The next day the patient is gotten up and encouraged to move the head freely to prevent any stiffening of the muscles. From this time general out-door treatment is advised.

In our series of cases we have had no mortality due directly to the operation. One patient died a few weeks after operation of general tuberculosis, and a second died in about three months from diffuse sepsis (Figs. 8 to 13).

TABLE OF CASES.

Total number of patients operated upon	649
Total number of operations	750
Average age	25
Number of cases under 10 years of age	18
Complete excisions	668
Curetted	62
Both sides operated upon	94
Recurrence in region of former operation (8.6 per cent.)	56
Died of pulmonary tuberculosis (5 per cent.)	19
Mortality (1 died in 4 weeks, 1 in 3 months, 4 in 1 year, 5 in 2 years, 2 in 3 years, 2 in 4 years, 1 in 5 years, 2 in 6 years, 1 in 8 years)	19
Died of tuberculous lesions other than pulmonary	9
Mortality (2 meningitis, 5 diffuse tuberculosis, 2 tuberculous peritonitis)	9
Died of other trouble	14
Number of patients with pulmonary tuberculosis at time of operation	10

METALLIC FOREIGN BODIES IN A BRONCHUS.*

WITH A REPORT OF TWO CASES.

BY GEORGE RYERSON FOWLER, M.D.,

OF BROOKLYN, NEW YORK.

THE distressing symptoms accompanying and following accidental inspiration of foreign bodies and the changes arising from their presence in the air-passages stamp this class of cases as extremely grave in character, and hence of the greatest importance to the surgeon.

In the early history of the subject it is to be noted that a prejudice existed against the performance of the operation of tracheotomy, through fear that the cartilages would not reunite, and it is to be presumed that many victims to these accidents perished in the early days who might have been saved by a prompt incision of the tracheal rings, an operation which, at the present day, is indicated not only in cases of lodgement of a solid foreign body in the upper air-passages, but also those in which it is situated low down in the respiratory tract.

Metallic foreign bodies in the bronchi form a class by themselves. The advances in methods of diagnosis of metallic foreign bodies in the organism in general made in recent years suggest this classification. The certainty with which the X-rays make the identification of metallic foreign bodies in general possible, and the ease with which the X-ray diagnosis may be verified in the case of those situated in the bronchi by instruments constructed on the principle of the telephonic probe of Girdner constitute a marked advance in the surgery of foreign bodies.

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* Read before the New York Surgical Society, Dec. 13, 1905.

EDITOR'S NOTE.—This contribution was found among the manuscripts of the late George Ryerson Fowler and, never having appeared in print, is sent for publication by his sons, Dr. Russell S. Fowler and Dr. Royale H. Fowler.

The question of the point of final lodgement of foreign bodies in the bronchi is of interest in this connection, and here two divisions must be made of the subject. For instance, those that are irregular in shape, such as hooks, safety-pins, etc., and which may lodge at various points above the point where the respiratory tube becomes sufficiently narrow to arrest their further progress, as well as coins and similar objects that may lodge either transversely or be placed on edge and either partially or completely occlude the bronchus, form a group separate from those that are regular and smooth in outline and pass directly to a point where their arrest is coincident with complete occlusion of the bronchus and consequent collapse of the lung beyond the point of occlusion. Further, the question of complete or partial occlusion may turn upon other peculiarities of form of the foreign body. For instance, hollow bodies or those that are tube-like in character, with a continuous lumen and an opening at each end, and which, when placed in the long axis of the bronchus do not prevent the passage of air, such as tracheotomy cannulas, form a peculiar group. Finally, there is another class of tubular metallic foreign bodies in a bronchus that have furnished several examples in the literature, namely, those with one end closed. The most familiar of these is the common pencil cap, a device employed to protect the point of a lead-pencil when carried in the pocket.

As between the two primary bronchi it is the general belief that foreign bodies entering the upper air-passages with few exceptions pass into the right bronchus. This has been attributed to, (1) the greater volume of the right bronchus due to the functional inequality of the two lungs, the left having one lobe less to supply with air than the right; (2) the fact, pointed out by Dr. Goodall, of Dublin, that the septum placed at the lower part of the trachea between the two bronchi is situated somewhat to the left of the median line, as a result of which the lumen of the right bronchus is more directly in the line of the axis of the trachea than the left, and a foreign body in its passage from the trachea will, by virtue of the laws

of gravity, be directed toward the right bronchus; (3) the force of the current of inspired air is greater on the right than on the left side, owing to the inequality of respiratory function of the two sides, this serving to direct the foreign body to the right (Poulet).

In spite of these anatomic and physiologic reasons why the foreign body should find its point of lodgement in the right bronchus in almost every instance, the fact remains that, according to the most conservative estimate, at least one-third find their way into the left bronchus (Gross, Boudillat, and others). On the other hand, Dr. W. B. Cheadle[1] collected from the English journals 34 cases of foreign body in a bronchus, in 30 of which the position of the foreign body was stated. Of these, in 16 it was lodged in the left bronchus, and in 14 in the right. Adding to this 3 cases coming under his own observation, in all of which lodgement took place in the left bronchus, we have 19 cases in the left to 14 in the right. Although this estimate is based on comparatively few cases, the figures are suggestive, at least, of the frequency of the entry of a foreign body into the left bronchus.

Of metallic foreign bodies of tubular form, those with both ends open, and which permit free entrance and exit of air, give rise to an entirely different train of symptoms when arrested in the bronchus from those present when occlusion of the bronchus takes place. The symptoms caused by the passage of the foreign body through the glottic opening and past the vocal cords differ according to the size of the lumen of the object. When the lumen is small the symptoms are practically the same as when a solid body is present, namely, those of impending suffocation due to energetic contraction of the irritated glottic opening and larynx. When the lumen is large the foreign body resting in the glottic opening or in the larynx becomes practically an intubation tube. Likewise when the foreign body is lodged in a bronchus, the differences are marked in direct proportion to the diminution of the calibre of the tubular object and the freedom with which air passes

[1] Medico-Chirurgical Transactions, vol. lxxi, 113.

through the lumen of the latter to and from the corresponding lung. In cases of impaction of detached tracheotomy cannulas in the bronchi, the symptoms may be of so mild a character as to lead to a disbelief on the part of the medical attendant in the patient's statements, as occurred in a case recorded by Clement Lucas. Examination of the chest in this class of cases reveals nothing to call attention to the presence of the foreign body. Resonance persists everywhere, and the respiratory murmur is but slightly if at all interfered with, the air passing into the alveoli comparatively unimpeded. The clinical picture presented in the above class of cases becomes more and more striking in contrast with that which is presented in cases of tubular foreign bodies of lesser calibre in proportion to the obstruction offered by the latter to the free passage of air, until, finally, the lumen may be so small as to convert the object into practically a solid foreign body.

On the other hand the lodgement of solid foreign bodies in the bronchi gives rise to a train of characteristic symptoms, these being attributable, first, to the suppression of the function of the corresponding lung, second, to changes in the lung tissue due to collapse of the alveoli, and third, to inflammatory septic conditions following the prolonged presence of the foreign body in the bronchus such as acute followed by chronic bronchitis, pulmonary emphysema, and, rarely, by ulceration of the wall of the latter. Escape of the foreign body into the surrounding lung structure may or may not follow ulceration of the wall of the bronchus, but in any event, with the occurrence of the latter septic pneumonia follows, terminating in abscess or gangrene. The prolonged presence of a foreign body, whether tubular or solid, or partially or completely occlusive, in a bronchus without giving rise to grave symptoms is one of the rarest occurrences in surgical experience.

In connection with the question of calibre it is to be remarked that foreign bodies that obstruct the right bronchus are much more dangerous than those that obstruct the left, for the reason that a much larger respiratory area is compromised. Further, sudden, complete, and permanent occlusion of either

primary bronchus is apt to prove fatal early in the case, for the reason that compensatory action on the part of the other lung cannot be established with sufficient promptness to prolong life.

The following instances of metallic foreign body in a bronchus are brought forward as contributions to the literature of the subject. The special interesting features of the cases relate, first, to the fact that in one of them, as in the case of Clement Lucas, scarcely any symptoms were present to support the patient's assertion that his tracheotomy tube had slipped away and passed " down somewhere " as he stated it, that the case antedated the use of the Röntgen rays in surgery, and therefore the presence of the foreign body was only discoverable by the aid of the telephone probe, and that this accident occurred to the same patient upon a second occasion, with precisely the same absence of symptoms, was identified in the same manner, and removed by the same means. In the other case the presence of the foreign body in the bronchus, likewise metallic and tubular in character, but with one end closed, gave rise to the most pronounced symptoms. In the second case the diagnosis, made by Dr. Linder who was called to see the boy in consultation with the family physician, was verified by the X-rays, and in both cases the steps taken for the removal of the foreign body were greatly facilitated and made both certain and safe by the employment of forceps connected with the telephone receiver in the manner employed in the use of the telephonic probe of Girdner.

Case I.—Methodist Episcopal Hospital, No. 2982. J. L., age thirty-five, farm laborer, admitted March 14, 1892. A little over a year previously while in a fit of drunken despondency he had attempted suicide by cutting his throat. He had made a number of slashes, but only succeeded in severing the epiglottis and wounding the neighboring soft parts in several places. Owing to the presence of a large amount of cicatricial tissue following the healing, it had been necessary for him to wear a tracheotomy tube ever since. This was made of aluminum. On the night preceding his admission to the hospital he had retired

with the tube intact and in place. Upon awaking in the morning he found the shield part of the tube fastened to the tape about his neck, but the tube itself was missing. He was not conscious of its presence in the air-passages, but supposed it to be there, as he could not account for its absence otherwise.

There was no dyspnœa, no cough, nor other discomfort attributable to the lodgement of the tube in a bronchus. The patient's only anxiety was the fear that he might not recover the tube, and be thereby compelled to purchase another. An examination of the chest organs was negative.

A telephonic probe was improvised by means of the ordinary Bell receiver of the telephone system, a sound gauge served as a large metallic electrode, a long silver probe of the common pattern, and a pair of conducting cords from the battery in the ward completed the apparatus. The circuit through the telephone was completed by moistening the plate with a solution of common salt and pressing it firmly against the surface of the chest wall.

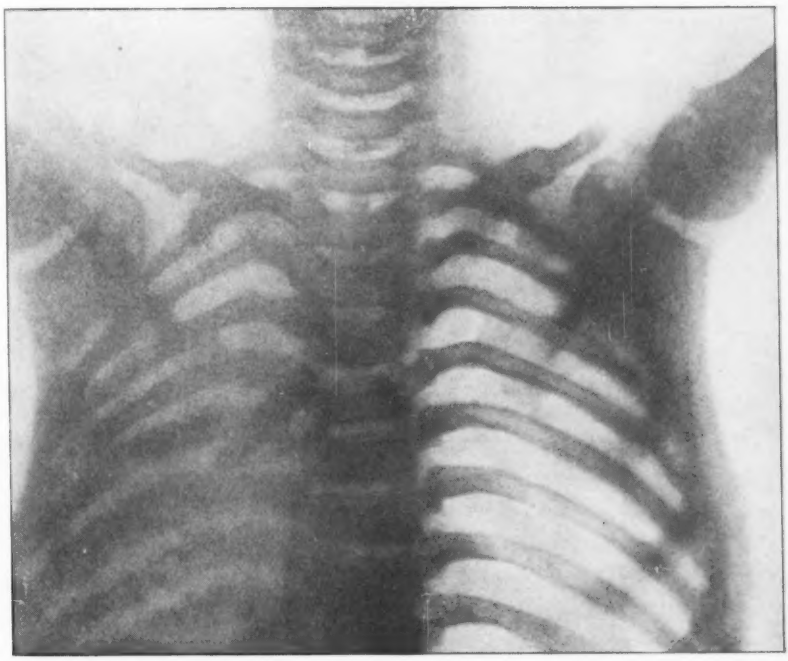
An opening was made in the trachea as low as possible, and with the edges retracted the improvised telephonic probe was passed, first, into the right bronchus, but without encountering the tube. It was then slightly bent at its extremity and again introduced, and directed this time toward the left bronchus. The characteristic grating sound heard in the receiver held to my ear by an assistant showed that the probe was passing over the inner surface of the lost tracheotomy tube.

The probe was then withdrawn and a flexible throat forceps substituted for it in the telephonic circuit. This was then introduced in the direction of the left bronchus. The same grating sound announced its contact with the tracheotomy tube. When the distance travelled by the passage of the forceps was judged to be a half inch greater than the length of the tube, the jaws of the forceps, which up to this time had been closed and partially concealed in the flexible shank of the instrument, were projected and opened, and the forceps withdrawn with the tracheotomy tube strung onto its stem.

The low tracheotomy wound was allowed to heal and the patient was discharged wearing a silver tracheotomy cannula, which he was advised to watch carefully that it did not become loosened from the shield.

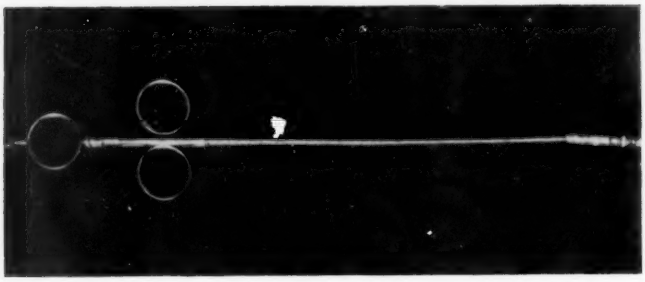
In spite of the warning given, and his past experience as

FIG. 1.



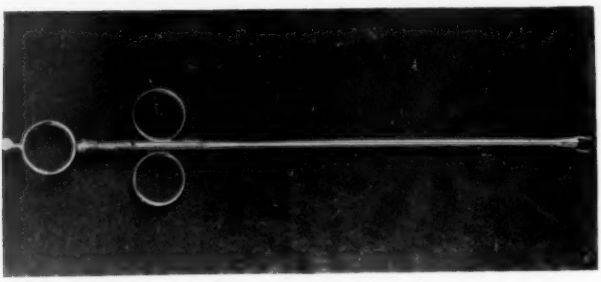
X-ray photograph showing pencil top in left bronchus.

FIG. 2.



Modified Wells bullet forceps in telephonic circuit, grasping the foreign body.

FIG. 3.



Modified Wells bullet forceps, prongs partly open.

FIG. 4.

Lead pencil cap removed from bronchus.

well, he again applied for admission to the hospital three and a half years later (October 3, 1895, Hospital Case No. 6281) with the same story of having "swallowed" the tube. On this occasion, however, he was awake when the accident occurred, and was stooping over washing his face when he felt the tube detach itself from the cannula. There was a momentary sense as of something slipping down, but that was all.

The same steps were taken to identify and recover the tube as on the first occasion, and with the same success. When discharged from the hospital on this occasion he was provided with a hard rubber tube, since which time he seems to have had no further trouble.

CASE II.—German Hospital, Brooklyn, Hospital Case No. 7963. W. M., age eleven, school boy, admitted November 6, 1905. Six days before admission, while sucking a metal pencil cap the latter slipped past the back of his tongue. He was seized with a violent fit of coughing and severe dyspnœa. His parents hurried him to a hospital in the neighborhood, where he was given a glass of water to drink. He immediately said that he felt better, and that the pencil cap had gone down, meaning that he had swallowed it. On his return home, however, he continued to have paroxysms of coughing, during which he became very cyanotic.

He was seen at this time by Dr. Linder, who noted labored breathing, the accessory respiratory muscles being called into play, and marked retraction of the left anterior chest wall on inspiration. Percussion showed dulness, amounting almost to flatness, on the left side. Auscultation revealed absence of breath sounds over the retracted area and diminished breathing over the upper left chest. There was tubular breathing over the upper lobe of the right lung. The heart's action was rapid and tumultuous.

A fluoroscopic examination was made and the foreign body found to be situated on the left side and lying in an oblique direction, corresponding to the left bronchus. Its centre apparently rested opposite the sixth rib. Judging from the relations that it bore to the available landmarks of the bony chest wall, and from the fact that some air entered the upper lobe of the left lung, it was estimated that the branch of the left primary bronchus leading to the latter was only partially occluded (Fig. 1).

A duplicate of the pencil cap was procured for the purpose of adapting or constructing an instrument for the removal of the foreign body. The latter was found to be tubular in shape, one and one-half inches long by about a quarter of an inch in diameter, and closed at one end. Near the closed end an ornamental bead had been spun in the metal.

With the aid of Mr. Julius Pfarre, of Tiemann and Company, an instrument was adapted for the removal of the pencil cap embodying the features of flexibility, proper direction of grasp, and a telephonic probe attachment. The instrument known as Wells's bullet forceps was modified for the purpose. The modification consisted in changing the direction of the jaws, so that instead of grasping an object from without as the wire stem within the flexible shank or cannula is pushed forward, as was originally intended, it would grasp a tubular body from within as the stem was withdrawn (Figs. 2 and 3).

On November 8, eight days following the accident, under chloroform, the operation of low tracheotomy was performed, and a half-round section of the tracheal rings on each side of the tracheal wound removed by means of the tracheal chondrotome. The skin on each side of the incision and the corresponding sternohyoid and sternothyroid muscles were sutured together with catgut. This gave ample working room without the necessity for forcible retraction of the edges of the incision. The telephonic forceps was then introduced and directed toward the left primary bronchus. A click followed by a fine grating sound in the receiver at my ear announced that the forceps had entered the tube of the pencil cap. Knowing the shape of the foreign body, no hesitancy was now felt in pushing the instrument onward until its farther progress was arrested by the closed end of the cap. The sliding stem within the cannula-like shank of the instrument was then withdrawn, thus expanding the jaws and engaging these on the inner surface of the tube. Their hold was increased by the presence of the ornamental bead referred to. Once engaged the forceps were slowly withdrawn and with it the pencil cap (Fig. 4).

A tracheotomy tube was placed in position temporarily. This was removed after twenty-four hours, and the wound allowed to close. The collapsed lung slowly expanded, and when examined by Dr. Linder a few days later had practically regained its normal condition.

Remarks.—Instances are not wanting in the literature of the detachment of a tracheotomy cannula from its shield and passage into a bronchus. Tubular foreign bodies have been removed by means of a metallic wire curved like a hook. In a case reported by Adler,[2] in which a piece of pipe stem was lodged in the right bronchus of a child of seven, the first attempt at removal resulted in transferring the foreign body to the left bronchus, from which place it was recovered on the following day by the above mentioned device.

A device improvised by Helferich[3] is worthy of mention in this connection. The foreign body, a metal pencil holder, was located in the left bronchus of a child of six, the situation of which was determined by the X-rays. The operator attached a rubber finger cot to a long tube and passed it into the open end of the pencil holder. The finger cot was then inflated and, thus engaging the tubular foreign body, the latter was removed.

In the very interesting case reported by Dr. Cheadle[4] the foreign body, which appears to have been somewhat like the pencil cap herewith reported, was likewise lodged in the left bronchus. In this case, as in my own, the tube had fortunately passed with the closed end first, thus leaving the open end presenting. A low tracheotomy was performed and through the opening thus made the forceps used for removing the intubation tube (O'Dwyer) was introduced. The open end of the tube was engaged by the forceps, the blades of the latter expanded, and thus secured the pencil cap was withdrawn.

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[2] Quoted by Poulet (Treatise on Foreign Bodies), vol. ii, 43.
[3] Zeitschrift für Chirurgie, lxvii.
[4] *Ibid.*

SARCOMA OF THE CLAVICLE: END-RESULTS FOLLOWING TOTAL EXCISION.*

BY WILLIAM B. COLEY, M.D.,

OF NEW YORK,

Attending Surgeon to the General Memorial Hospital; Attending Surgeon to the Hospital for Ruptured and Crippled; Professor of Clinical Surgery, Cornell Medical School.

THE first case of total excision of the clavicle for sarcoma was the famous case of Valentine Mott, operated upon on June 17, 1828, and published in the *American Journal of the Medical Sciences,* 1828, vol. iii, p. 100.

In Mott's case the tumor had been first noticed in February, 1828, and, as in my own case, followed shortly after a strain. The tumor was treated for a considerable time with plasters, poultices, a seton, and escharotics. At the time of operation it was 4 inches in diameter, of " incompressible hardness," and a portion of it was covered with fungous granulations. Mott gives a very detailed description of the operation. He states that " the patient lost some 16 to 20 ounces of blood, that the tumor was about the size of a man's doubled fist. It consisted of a bony cup, was incompressibly hard at all parts, except superiorly and inferiorly to a small extent. From an elliptical opening in the upper part, protruded a bleeding fungus, the size of half a hen's egg." He states: " This operation far surpassed in tediousness, difficulty, and danger anything which I have ever witnessed or performed. It is impossible for any description which we are capable of giving to convey an accurate idea of its formidable nature. The attachment of the morbid mass to the important structure of the neck and shoulder of the left side, and to so great an extent, is sufficient to indicate its magnitude and difficulty." The wound healed by granulation. It is interesting to note Mott's statement that " the immense chasm which was left, and such impor-

* Read before the American Surgical Association, May 3, 4, 5, 1910, at Washington, D. C.

tant parts as have been described only covered with lint, necessarily occasioned great solicitude until suppuration was fully established and the great vessels covered by granulations."

Mott states that by means of an apparatus contrived by Mr. James Kent, a most ingenious and inventive artist, to supply the want of the clavicle, he was so fitted as to have his shoulder in its proper position, at the same time that the full motion of his arm was preserved.

Comparatively few cases of total excision of the clavicle for malignant diseases have been reported by American surgeons. G. Norkes,[1] in 1893, published a case observed at Brun's Clinic, and made a very careful analysis of the cases reported in the medical literature up to that time. He found 31 cases of total excision for non-malignant and 32 for malignant tumors, of which 24 were sarcoma, 5 carcinoma (?), 2 exarthrosis, and one chondroma, with 6 deaths. It is probable that the cases put down as carcinoma were sarcoma, as primary carcinoma of the clavicle is practically unknown. Only one case died of septicæmia. Warren's case died four weeks afterward, of pleuritis or possibly metastases. Langenbeck's case died six days later from a swelling of the dura mater; Politz's case died on the eleventh day, from brain tumor, Sajous's on the eighth day, of fascial metastases; in Eves's case the cause of death was doubtful.

The immediate results in the majority of cases as regards usefulness of the arm were remarkably good. In many cases, without the use of apparatus of any kind the patients were able to use the arm as well as before.

As regards end-results, the statistics of Norkes are extremely deficient; only 2 cases are known to have lived and remained well beyond two years.

Since the publication of Norkes's paper in 1893, I have been able to find in the medical literature reports of 20 additional cases. Adding to these 10 thus far unreported cases, which have come to my notice through personal communica-

[1] Beitr. z. klin. Chir., 1893, Band xi, p. 729.

tions from the surgeons who performed the operations, we have a total of 62 cases.

It is with special reference to the following unpublished cases and especially those which have come under my own observation that this paper has been written.

CASE I.—*Sarcoma of the clavicle; round-celled; total excision* (author's case). J. V., male, aged 16 years.

Family History.—Good.

Past History.—Always well until the beginning of October, 1909, when, going down stairs he tripped and fell. Trying to save himself, he caught hold of the banister with his left hand, which brought him up so suddenly that it caused a good deal of strain upon his left shoulder and clavicle. Shortly after that, while riding a motor cycle, the latter broke down and he was obliged to tow for a distance of ten miles, during which time he held on to the tow iron with the left hand. End of October, he first noticed pain and soreness in the region of the left clavicle, but did not notice any swelling until a week later. He consulted Dr. Alfred Potter, of Brooklyn, November 20. Dr. Potter found a fusiform enlargement of two-thirds of the inner portion of the shaft of the left clavicle. He had an X-ray made which presented the appearance of a typical periosteal sarcoma. The outline of the periosteum was very nearly lost; no enlarged glands were present. The tumor was about the size of an English walnut. The patient's general health was good; there was very little pain. The clinical history, physical signs, and the X-ray photograph made the diagnosis of sarcoma sufficiently certain, in my opinion, to warrant removal without subjecting the patient to the danger of an exploratory incision. Accordingly, two days later, November 22, 1909, with the assistance of Dr. W. A. Downes, I performed the operation of total excision of the clavicle. The incision was made over the outer surface of the clavicle over its entire length, and after separating periosteum and bone, Gigli's wire saw was passed beneath the clavicle one and a half inches from the outer extremity, well beyond the tumor. The inner and larger portion was then lifted up and dissected from the subclavian muscle and separated from its attachments until the sternocostal articulation was reached. Disarticulation was then accomplished with little difficulty and no hemorrhage. The outer

FIG. 1.

Total excision of clavicle for sarcoma of three weeks' duration in a boy aged sixteen years (Coley).

FIG. 2.

Recurrent sarcoma of clavicle six months after operation.

FIG. 3.

Sarcoma of clavicle of nine months' duration.

portion of the clavicle was thereupon removed by a rongeur forceps. The wound was closed, leaving a small cigarette drain. The patient made an uninterrupted recovery, the wound healing by primary union, and left the hospital at the end of ten days. Before leaving the hospital, he was put upon the mixed toxins of erysipelas and *Bacillus prodigiosus* in small doses, which were steadily continued by his family physician for a period of three months; the patient then considered himself so well that he refused further treatment. At the present time, November, 1910, almost a year after operation, the patient is in perfect health.

CASE II.—*Sarcoma of the clavicle; total excision* (DR. M. H. RICHARDSON) *followed by one year's treatment with the mixed toxins; patient well two years and a half.* J. W. H., aged 34 years.

Family History.—Father died of cancer of the stomach; no tuberculosis in family.

Past History.—Six or seven years ago a plank fell over and struck the patient upon the left clavicle, nearly knocking him down. He first noticed a swelling of the clavicle in January, 1908. A few weeks later, slight pain developed. He consulted a physician on January 19, 1908, who said he was unable to make a diagnosis. The swelling continued to increase slowly, and March 23 he consulted Dr. Hunt, of Bangor, Maine, who said it was sarcoma. The diagnosis was concurred in by Dr. S. W. Johnston, of Belfast Maine, who referred the patient to Dr. Maurice H. Richardson, of Boston. The latter did a total excision May 18, 1908. The tumor occupied the middle and inner thirds, and operation was difficult. Microscopic examination showed it to be small, round-celled sarcoma. As soon as the wound healed, Dr. Richardson referred the patient to me for the toxin treatment as a prophylactic against recurrence. At this time there was considerable infiltration in the whole lower cervical region, which was very suggestive of either a recurrence or incomplete removal. This gradually cleared up under the toxins and had entirely disappeared at the end of two months. The treatment was carried out under my direction by the family physician, Dr. H. L. Trulock, of Dixmont, Maine. The dose was gradually increased until he received 20 mm. Examination was made by myself in February, 1909, as also in July and October, at which time he had gained twenty-six pounds in weight and was in perfect health. The same is true at the present time, two years after operation. Dr. Richardson stated that he considered the absence of a recurrence in this case entirely due to the toxin treatment.

CASE III.[2]—DR. THOS. W. HUNTINGTON'S case (San Francisco, California, September 5, 1908). Mr. X., Pinole, California.

Family History.—Negative. Lues, negative; habits exceptionally good.

Past History.—Never had any serious illness. For the past eighteen months has been under Dr. Huntington's care for double salivary fistula.

[2] Dr. Huntington has kindly given his permission to include this unpublished and very important case.

Case not clearly made out and due to stenosis of Stenson's duct. One sinus is still open.

History of Present Trouble.—In September, 1906, while carrying a steel shaft with a fellow workman, his companion dropped his end, whereby Mr. X. sustained a severe contusion or bruise of the right clavicle at the junction of the outer and middle thirds. An enlargement at this point appeared within the next two or three weeks. This remained stationary for many months, but never wholly disappeared. Four months ago it began to grow quite rapidly, attaining its present size one month ago, since which time it has remained stationary.

Present Status.—The skin over the outer portion of the clavicle is reddened superficially, the area of redness covering a mass which is clearly associated with the shaft of the clavicle. The mass appears to be about the size of an ordinary English walnut, slightly elongated at the ends. The mass is indurated and irregular in outline. Fundus of the mass is clearly fluctuant. The largest diameter of this mass is fully twice that of the clavicle shaft. On examination the sensation conveyed is that the mass contains a fluid content in the centre, the outer portion remaining crater-like. It is sensitive upon pressure, but otherwise is painless. The patient's general health is fairly good, and he seems, thus far, not to show any general deterioration.

Operation, September 8, 1908.—At the University Hospital, Dr. Huntington resected the entire clavicle, removing a segment of skin overlying the centre of the tumor. Macroscopic appearance of the tumor verified the conditions outlined above. The tumor had undergone a degeneration in the centre. Contents, thick grumous material. The margins of the tumor arose from the periosteum, and though the shaft itself was involved, the pathological report was to the effect that the tumor was spindle-celled sarcoma of periosteal origin. The shaft of the bone had participated in the process secondarily. The operative wound was left open in the centre, but healed slowly by granulation after a period of nearly three months. At the end of two weeks, treatment by Coley's toxins was begun and continued for about five months.

On April 12, 1910, the patient was in excellent condition. Both parotid fistulas had been closed for many months.

Cases IV and V.—Mr. Gilbert Barling's cases, Birmingham, England (personal communication). (1) Miss S., aged 10 years, May, 1901. An injury to the left clavicle, doubtful fracture, probably not, but it seems likely that some swelling has existed in the region of the clavicle ever since that injury. When seen by me on January 22, 1902, a mass the size of the fist over the left clavicle, apparently fluctuating in parts, skin adherent and rather dusky, veins very much dilated; the swelling extended from half an inch outside the sternoclavicular joint nearly to the outer end of the clavicle; no swelling of the arm, no numbness or loss of power in the arm.

Diagnosis.—Sarcoma. Removal advised, but operation is not one that could strongly be recommended.

January 28, 1902: Complete removal of the left clavicle. There was very troublesome bleeding from small vessels but no injury to the large

veins. It was noticed that there was a good deal of œdema over the growth, as though it were of an inflammatory nature. The thoracic duct was injured, and chyle escaped into the wound but not in any large quantity. The small opening in the duct was closed by a lateral ligature.

The patient made a good recovery, but on February 1, 1902, it was noticed that there was a good deal of milky fluid escaping from the wound; this continued for several days in gradually diminishing quantities. The patient was up ten days after the operation.

Note on September 2, 1902: There was extensive recurrence in and around the scar impossible for removal. The patient died a few months afterward.

(2) *Spindle-celled sarcoma of the clavicle.* Seen April, 1889. Male, aged 33 years. Growth had existed several months and there was a fracture through the middle of it, produced probably by the manipulations of a bone setter who had been treating the patient. The growth was mainly of the inner half of the clavicle, was firm in consistence, without evidence of cystic formation.

Operation, April 12, 1889.—The operation went well, there was no injury to any of the big vessels, but there was straightaway infection of the wound and the patient died on the fourth day after the operation from suppuration extending down the mediastinum and giving rise to pleurisy.

CASE VI.—*Sarcoma of the clavicle, periosteal; total excision* (HARTLEY); *recurrence three months after operation.* G. M., aged 19 years.

Family History.—Good.

Past History.—No trauma.

First noticed a small lump above the left clavicle in March, 1907. He thinks it was movable at first, and states that it disappeared. A month and a half later the swelling reappeared and seemed to be attached to the clavicle. He consulted a physician, who treated him for rheumatism for a number of months. The tumor continued to increase in size. In April, 1909, he went to the New York Hospital and was admitted to the service of Dr. Frank Hartley, who did a total excision. The microscopic examination was made by Dr. Elser, who reported the disease to be a spindle-celled sarcoma. Three months later the patient noticed a local recurrence above and below the former site of the scapula. The patient was then referred to me, and I had him admitted to the General Memorial Hospital, September 28, 1909. By this time the patient had several recurrences occupying the whole upper portion of the right chest; the recurrent masses varied in size from a marble to three to four inches in diameter, and were situated beneath the pectoral muscle. Several smaller lumps had also appeared underneath the old scar and pectoral region (see illustration). The toxins were begun in small doses and gradually increased up to 14 minims. After two weeks there was considerable decrease in size of the various nodules and increased mobility. Shortly after that, however, the control was lost and the tumors again began to increase in size. December 1, 1909, it seemed useless to continue the treatment, and the patient was discharged from the hospital unimproved.

CASE VII.—*Round-celled sarcoma of the clavicle.* E. S., male, aged 21 years. In May the patient broke his left clavicle. One year afterward a swelling appeared at the site of the fracture and grew rapidly. The clavicle was partly removed by operation, but the disease quickly returned, soon involving the scapula. The patient was treated by myself with the mixed toxins for about four weeks, but without success. Excision of the remaining portion of the clavicle, the entire scapula, and upper extremity was later performed by Dr. W. W. Keen, of Philadelphia. The patient recovered from the operation, but died eight months later from a recurrence.

The following cases of sarcoma of the clavicle I have personally observed, but no operation was done on account of the extent of involvement when first seen.

CASE VIII.—*Sarcoma of the clavicle, recurrent; trauma.* W. F., male, aged 38 years.

Family History.—Always well until December, 1908, when he swung from trolley car, grasping rail by left hand. Immediately thereafter pain set in over the inner third of the clavicle; this subsided, but a week later he noticed a bony lump which he thought was the overlapping of the collar-bone. This tumor slowly increased in size, and three to four weeks later he consulted a surgeon who sent him to the Long Island College Hospital, where the diagnosis of tumor of the left clavicle was made. Operation was performed on February 5, 1909. The wound healed by primary union and the patient left the hospital on February 28. A week later he noticed a lump in the suprasternal fossa; this was painless, but gradually increased in size, and he returned to the hospital March 28. The treatment with the mixed toxins was begun, but discontinued after a few weeks, as there was no appreciable improvement. When I saw him a few weeks later the growth was so very extensive and signs of metastasis were already evident that I abandoned further treatment.

CASE IX.—H. K., aged 31 years.

Family History.—Good.

Past History.—In May, 1897, carried a heavy piece of steel on the right shoulder; one month later he noticed a lump directly over the clavicle at the point where the steel rested. The first

operation was done by Dr. Mayer, of Buffalo, in July, 1897, who removed a gland below the clavicle, the size of an English walnut; three weeks later a lump appeared in the axilla and rapid involvement of the surrounding tissues quickly followed. When I saw the patient, February 16, 1898, his general condition was very poor; he was confined to the bed most of the time; his right arm was greatly swollen down to the tips of the fingers. The whole neck and shoulder were occupied by an enormous tumor extending to the sternum in front and nearly to the vertebral column behind; the skin over the tumor was of a deep purplish color and the patient was unable to move the arm at the shoulder. No treatment advised.

Prognosis.—Six weeks to two months of life.

CASE X.—J. L., male, aged 8 years.

Family History.—Negative.

Past History.—Had a bad fall from a stone fence in October, 1905, injuring right shoulder and clavicle. Soon after a small lump formed in the clavicle; this was very soft and was supposed to be an abscess by his physician, who lanced it. End of December there was a recurrence, and in January, 1906, an exploratory operation was performed by Dr. Bodine, but it was impossible to remove the entire tumor. There was rapid increase of the disease thereafter and evidence of lung involvement. The patient was seen by me in March, 1906. Physical examination at this time showed the patient much emaciated; respirations, 40; pulse, 120 to 130; the right lung was nearly solid, and a large tumor in the region of the right clavicle infiltrated the adjoining tissues.

CASE XI.—T. B., male, aged forty-six years; good family history; antecedent trauma dislocation of shoulder. In June, 1902, he first noticed a stinging pain in the inner portion of the left clavicle. Shortly afterward, a small enlargement was noticed in this region. He began X-ray treatment under the direction of Prof. J. Collins Warren, in November, 1902, and continued until March, 1903, two to three times a week, with considerable diminution in size of the tumor. In October, 1903, a specimen was removed by Dr. Warren and found to be round-celled sarcoma. The X-ray treatment was then resumed and continued until February, 1904, with the result that the tumor almost entirely disappeared. Later, however, it began to increase again

in size and a third series of treatments was begun in August, 1904, and continued until October, 1904, with little effect. In October, 1904, the patient was referred to me by Dr. Warren for the mixed toxin treatment. Physical examination at this time showed a pear-shaped tumor, occupying the sternal portion of the left clavicle, 2½ x 5½ in. in diameter, occupying about two-thirds of the inner portion of the clavicle. The skin was normal and not adherent. The glands above and below the clavicle were somewhat involved, and there was slight enlargement of the left arm. The mixed toxins were administered in the pectoral region and buttocks from October 6 to November 26, 1904, during which time 31 injections were given in doses ranging from ½ to 4 minims, with moderately fair reactions, the temperature ranging between 99° and 102°. The X-ray treatment was given in conjunction with the toxins, three times a week. At first there was slight retardation of the growth, but later there was no apparent effect; the tumor again continued to increase in size and the treatment was abandoned. The patient grew worse steadily and died about a year later.

CASE XII.—H. B., male, age twenty, electrician. Family history good. No single trauma but accustomed to carrying heavy materials upon left shoulder, *e.g.*, iron pipe.

Pain in shoulder for more than a year before any tumor was noticed. Small tumor first observed on outer portion of left clavicle in January, 1910. Operation (Dr. Stewart, Newport, R. I.) March, 1910. Tumor size of English walnut removed from outer end of left clavicle. Clavicle itself not resected. Microscopical examination showed tumor to be round-celled sarcoma, periosteal. Recurrence in three weeks. Very rapid growth followed. Patient under my care at General Memorial Hospital September 15 to October 20, 1910. Mixed toxins given in as large doses as deemed safe. Result little or no effect in controlling growth. Treatment discontinued. Prognosis, two or three months of life.

THE DIAGNOSIS OF SARCOMA OF THE CLAVICLE.—That the diagnosis of cancer of the clavicle must be made early if there is to be a probability of saving the patient, a study of the collected cases makes very clear. It is true that Mott's case was far advanced, but it was of central origin, not of the more

malignant periosteal type. No variety of tumor is more malignant than many of these cases of periosteal sarcoma of the clavicle. The proximity of large vessels insures an abundant blood supply, and consequently we have early infiltration and very rapid generalization.

That the diagnosis of sarcoma of the clavicle in the very early stages is possible is shown by my own case, in which total excision was performed three weeks after the swelling was first noted.

A distinct history of antecedent trauma was noted in 7 of the 9 cases of sarcoma of the clavicle personally observed. In most cases there was a history of a swelling having been noted a short time after the receipt of an injury. This swelling is intimately connected with the bone, of hard, firm consistence, not usually the "bony hardness" described by Mott, but often there is a slight yielding on deep pressure; the skin is normal in the early stages; later there may be dilated veins, but it is never adherent to the deeper structures except in the very late stages—too late for any attempt at operation. Pain is usually absent. The neighboring glands are seldom enlarged.

X-ray examination is of very great aid in diagnosis, especially in tumors of central origin. In most cases of periosteal sarcoma the X-ray plate will show a fairly characteristic picture. The sharp outline of the bone is nearly always lost, although I have just had a case of periosteal sarcoma of the femur in the early stages, in a girl aged twenty years, in which the outline was absolutely distinct, the probable explanation being that she was seen at such an early stage that no infiltration of the bone proper had taken place as yet.

One must differentiate the condition from tuberculosis. A history of tuberculosis in the family, or evidence of tuberculosis in the glands or some other portion of the body, would justify one in ruling out sarcoma. It is extremely rare to find primary tuberculosis of the clavicle. Sarcoma is prone to occur in strong and healthy individuals—more often in the young or middle-aged than the elderly.

Syphilis.—A history of syphilis may usually be elicited by

careful questioning; in addition, a physical examination would probably show other bones than the clavicle affected. Besides, a syphilitic tumor would be of much slower growth.

Myositis Ossificans.—This in itself is a rare condition, and I do not know of any cases that have occurred in the clavicle. The X-rays would be of very great help in making the differential diagnosis.

If clinical history, physical examination, and X-ray findings all point to sarcoma, shall we then cut into the tumor and remove a section for microscopic examination before performing the operation of complete or partial excision of the clavicle? In most cases, I should say "no"; at least, I would prepare for the major operation, and, in case of doubt, would have a microscopic examination made from the frozen section at the time of operation. But, in some cases—my own among the number—it is impossible to make a satisfactory examination from the frozen section, for the reason that decalcification of the bone must first be made.

To one who has had large experience in operations upon sarcoma of the bones, macroscopic examination of the tissue, together with the clinical history and physical signs, will, in nearly all cases, be sufficient to make an error of diagnosis exceedingly rare. Therefore, in a rapidly growing tumor of the clavicle, I would perform total or partial excision, according to the condition found in the individual case, without waiting for the result of a microscopic examination. In some cases it is possible to make frozen sections at the time of operation which might be of some value.

After operation, as soon as the wound has sufficiently healed, I would very strongly urge prolonged treatment with the mixed toxins of erysipelas and *Bacillus prodigiosus,* as a prophylactic against recurrence.

In the cases thus far reported, there has been an early recurrence in the great majority of cases that have been traced. Only three cases are known to have been well beyond a period of three years.

The prophylactic treatment with the toxins is entirely free

from danger and can easily be carried out by the family physician.

Of course, it would be unscientific to claim that, because a number of cases of sarcoma in which the toxins had been used after operation remained free from recurrence, this result was due to the use of the toxins. Unless the number of cases were very large, such results might be explained by coincidences, without any relation of cause and effect. Yet the fact that in the cases of sarcoma of the long bones generally, in which the toxins have been used, recurrences have been less than one-third as frequent as in the cases in which they were not used, would seem to justify the conclusion that the treatment played some part in lessening the number of recurrences.

I did not advocate the toxins as a prophylactic after primary operation for sarcoma until comparatively recently, and not until I had seen a large number of cases of inoperable sarcoma entirely disappear under the treatment and remain permanently cured. If the toxins can cause a disappearance and final cure in such far-advanced, inoperable cases of sarcoma, a logical and entirely reasonable inference is that the toxins used after primary operation would be still more likely to destroy the few infected cells left behind that form the basis of future return.

The influence of trauma upon the development of sarcoma, and, in fact, upon the development of all types of malignant tumors, is a question which has elicited much discussion pro and con. Phelps, in the ANNALS OF SURGERY, June, 1908, made an elaborate attempt to disprove any causal relationship between trauma and the development of cancer; he limits the discussion to carcinoma.

For more than twenty years I have made a very careful study of the relationship between injury and the development of malignant tumors, and I have become more and more firmly convinced that injury plays a most important rôle in such development, both in sarcoma and in carcinoma. These cases of sarcoma of the clavicle show more strongly than any others, perhaps, the intimate connection between an antecedent trauma and the sarcoma. The association of the injury with the

rapidly following development of the tumor would appear far too striking to be easily explained away as a mere coincidence.

Trauma.—Of the 9 cases of sarcoma of the clavicle there was history of trauma in 7 of the cases, and in one of the two remaining cases the patient had carried heavy weights upon the clavicle in which the sarcoma developed.

Case I: Sarcoma of the left clavicle; a heavy plank fell upon the left clavicle six years before.

Case II: Sudden severe strain of shoulder while getting off a trolley car; immediate pain; tumor noticed one week later; operation four to five weeks later.

Case III: Severe strain of clavicle from grasping banister to prevent falling down stairs; tumor noticed one week later.

Case IV: Dislocation of shoulder; tumor of clavicle noticed two to three months later; round-celled periosteal.

Case V: Fractured clavicle; tumor appeared one year later at exact site of fracture.

Case VI: Had a fall from stone fence, striking on clavicle; tumor appeared almost immediately after.

Case VII: No trauma.

Case VIII: Bruised by carrying heavy bars of steel upon shoulder and clavicle; tumor developed at the exact site, one month later.

Case IX: An electrician, and habitually carried heavy materials upon shoulder of side in which sarcoma developed.

Analysis of the Cases.—As regards the age of the patients, in 1 case the sarcoma was noticed at birth; 2 cases were between one and ten years; 19 cases were between ten and twenty years; 9 cases were between twenty and thirty years; 12 cases were between thirty and forty years; 7 cases were between forty and fifty years; 1 case was between fifty and sixty years; 3 cases were between sixty and seventy years.

As regards the type of the growth in the successful cases: Mott's case was probably of central origin, well fifty years; Wheaton's case, type not stated, well ten years; Norkes's case, myeloid growth, well five years; M. H. Richardson's case, periosteal growth, well two years; Huntington's case, peri-

osteal growth, well two years; my own case, of central origin, well seven months.

Results of Operation.—Eleven cases died from the effects of the operation. In 1 case there was a recurrence four years after operation; in 1 case there was a recurrence eighteen months after operation; in 1 case a sarcoma of the femur developed three months after operation; in 1 case there was a local recurrence six months after operation; in 1 case there was a recurrence soon after; in 1 case there was a recurrence in the upper jaw nine years after operation; 1 case was well five months later; 1 case recurred a few months later; 1 case recurred within three months; 1 case recurred within two months. In these 10 cases recurrence was noticed within the first six months in 7 cases; 1 recurred in four years, 1 in eighteen months, and 1 in nine years. Six cases were well at the time of the last observation: Mott's case was well fifty years; 1 case well ten years; 1 case well five years; 1 case well two years; 1 case well one and one-half months; 1 case well seven months. In 3 of these cases the toxins were used immediately after operation as a prophylactic (Richardson's, Huntington's, and my own). In the remainder of the cases the final results are not known.

Conclusions.—1. Primary sarcoma of the clavicle, while a rare condition, requires very early diagnosis and very early radical treatment—total or partial excision as soon as the diagnosis has been made.

2. The mortality of the operation performed under modern aseptic conditions should be very small.

3. The danger of early local or general metastases is very great.

4. In view of the favorable results obtained in the few cases of sarcoma of the clavicle, and the much larger number of cases of sarcoma of the long bones in general, by the use of the mixed toxins of erysipelas and *Bacillus prodigiosus* immediately after operation, as a prophylactic, such use would seem to be strongly indicated as a routine measure.

TABLE OF REPORTED CASES OF SARCOMA OF CLAVICLE.

No.	Reporter.	Date.	Reference.	Sex.	Age.	Side.	Site.	Duration.	Description	Operation.	Type.	Result.	Final report.	Remarks.
1	Mott	1829	Amer. Jour. Med. Sci., 1828, iii, 100	M	19	L	Beneath and adherent to clavicle	.....	Size of two fists	.....	Osteo. with ulceration	Recovery	Well 50 years	
2	Warren	(1832) 1837	Surg. Obs. of Tumors, p. 405	M	24	R	Inner end	.....	.....	Total excision	Pulsating	.....	.....	Died of pleurisy 4 weeks after
3	Travers	1838	Med. and Surg. Trans., xxi, 135	M	10	L	Inner end	1 year	.....	Total excision	Osteo.	Recovery	Well 6 mos.	Trauma
4	Liston	1844	Lancet, p. 361	M	..	..	.....	.....	.....	Total excision	Soft	Recovery	Recurred in 3–4 months	
5	Chaumet	1849	Gaz. Med. de Paris	F	18	L	Outer	9 months	Size of fist	Resection of external four-fifths	.....	Recovery		
6	Gallardon	1847	Gaz. des Hop.	F	45	..	Middle, sternum, 1st rib	.....	.....	No operation	Vascular pulsating	.....	.....	Died of bronchopneumonia
7	Rigaud	1850	Gaz. Med. Strasbourg, A. X., p. 103	F	15	L	Inner	7 years	Size of fist	Resection of inner two-thirds	.....	Recovery		
8	Owens	1854	New Orleans M. and S. J., xii, 64	..	..	..	.....	.....	.....	.....	.....	.....	.....	Doubtful
9	Langenbeck	1855	Deutsch. Klinik	F	11	L	Both ends	.....	.....	.....	Spindle cell	Died on 6th day		
10	Syme	1857	Ed. Med. J., iii, Pt. I, 192	F	20	..	Outer end	.....	$3\frac{1}{2} \times 4\frac{1}{2}$ cm.	Total excision	Osteo.; myeloid cells; cystic	Recovery		
11	Cooper	1858	Gaz. de Hop.	..	..	L	.....	.....	.....	Total resection	.....			
12	Esmärck	1859	Nissen. Diss. de resect. Kiliae	M	33	R	.....	.....	Size of a hen's egg	.....	.....	Recovery	Recurrence; died in 4 yrs.	

13	Nélaton	1860	Thesis de Paris	F	46	R	Inner end and sternum	2 years	.....	.....	Myeloid	.....	.....	Died of bronchitis
14	Gosselin	1861	Bull. Soc. de Chir., 2d series, ii	M	37	R	Inner third	.....	Size of a lemon	Resection of inner third	Fibrous elements	.....	.....	Fracture
15	Pean	1861	Gaz. de Hop., p. 419	M	37	..	.....	.....	Size of a citron	.....	Spindle cell			
16	Nélaton	1863	Bull. Soc. Anat., 2d series	F	30	..	Middle	.....	.....	.....	Fibrous and fibroplastic			
17	Richet	1864	Dict. de Med. et de Chir. Pratiq., viii	M	65	R	Inner third	2 years	.....	Resection of inner third	Myeloid	.....	Recurred 18 months after in scar	
18	Paquet	1867	Bull. de la Soc. Anat., p. 634	M	21	R	Inner end sternum, 1st rib	6 months	12 x 8 cm.	No operation	Embryonic and myeloid	.....	.....	Died
19	Delore	1868	Gaz. Med. de Lyon, iii, 93	..	..	..	Inner end	.....	.....	.....	Medullary carcinoma	Recovery	.....	Doubtful
20	Morin	1868	Ibid.	..	Child	..	.....	.....	.....	.....	Carcinoma	.....	.....	Doubtful
21	Meyer	1868	Gaz. Med. de Lyon, No. 8, p. 93	..	..	..	.....	.....	.....	.....	.....	.....	.....	Doubtful
22	Sean and Eve	1869	Chicago Med. Exam., x, 653	M	12	L	End	14 months	.....	Vein injured at operation	.....	.....	.....	Cervical glands enlarged; died from exhaustion
23	Cooley	1870	St. Louis Med. and Surg. Jour., p. 62	M	30	L	Middle	.....	.....	.....	.....	Recovery		
24	Britton	1870	Brit. Med. Jour., i, 518	M	35	L	Outer end	2 years	Size of an orange	Resection of all except acrom. end.	.....	Recovery		
25	Eve	1871	Nashville Jour. Med. and Surg., i, 68	M	13	L	.....	7 months	Size of an ovary	.....	Enchondroma (red, flesh-like)	Died	.....	Doubtful; spontaneous fracture
26	Richet and Demondre	1873	Paris Thesis	F	51	L	Outer end	3 months	Size of an orange	Resection of outer end				

No.	Reporter.	Date.	Reference.	Sex.	Age.	Side.	Site.	Duration.	Description	Operation.	Type.	Result.	Final report.	Remarks.
27	Tausini	1883	Gaz. degli Ospitali, Milano, No. 39, p. 306	F	30	..	Inner end	.....	Size of an egg	.....	Myxœdema	Healed in 15 days		
28	Deprès	1885	Bull. de Soc. de Chir., pp. 143–226	F	14	R	Outer end	.....	Size of an orange	.....	Central	In hospital 31 days		
29	Segoud	1885	Ibid.	M	66	..	.....	.....	.....	.....	.....	Died on 8th day of visceral involvement		
30	Polleaillon	1885	Bull. de Soc. de Chir., p. 146	M	16	R	Outer end	18 months	Size of fist	Resection of external three-fourths	.....	Recovery	Well 3 months died of sarcoma of femur	
31	Kronlein and Ritter	1885	Inaug. Diss. Zurich	F	17	L	Central part	.....	.....	Total resection	Periosteal; round cell	.....	Prompt recurrence; well 10 yrs.	
32	Wheeler	1885	Trans. Acad. Med. of Ireland	M	43	L	.....	.....	.....	.....	.....	.....	.....	Slight blow; phthisis; imp.; well 10 years later
33	Sloan	1887	Am. Jour. Med. Sci., p. 485	M	14	R	.....	.....	.....	.....	Carcinoma (?)	.....	Recurred 6 months after	Doubtful
34	Heath	1888	Lancet, i, 721	M	30	L	Outer end	3 years, 10 months	.....	.....	Spindle and round cell	7 days after operation developed br. symptoms	Died on 11th day	
35	Chiene	1888	Lancet, i	F	15									

36	Wauscher	1889	Hosp. Tiden de Kopenhagen, Feb., i, 310	M	18	..	.....	.....	.....	.....	Myelogenous	.....	Soon recurred	
37	Rouse	1889	Lancet, i. 575	M	29	..	Inner end	6 weeks	Size of an egg	Resection of inner two-thirds	.....	Died of sepsis	.....	Vein injured
38	Jesset	1889	Lancet, p. 1077	F	18	R	Inner end	.....	.....	.....	.....	Healed in 2 months		
39	Harlam	1863	Brit. Med. Jour., p. 848	M	31	..	.....	.....	.....	.....	Periosteal; round cell	Primary union	Well 5 mos.	
40	Garre-Norkus	1893	Beitrag. zur. klin. Chir., ii	F	31	R	Outer end	1 year	2 in. long	Total excision	Myeloid; pulsating	Immediate recovery	Well 5 years	
41	Curtis-Norkus	1893	Am. Jour. Med. Sci., xxxiv, 350	F	20	L	.....	5 years	.....	.....	Osteosarcoma	Recovery	.....	Probably syphilitic
42	Leguen	1895	Bull. Soc. Anat.	F	24	..	.....	3 months	Nut	Total excision	.....	.....	.....	Pulmonary tuberculosis
43	Courtin	1897	Gaz. Hbd. des. Sc. Med. de Bordeaux, xviii	F	Birth	L	Middle and inner end	.....	.....	.....	Osteo.	.....	Lived 1 mo.	
44	Verstraete	1898	Jour. de Sc. Med. de Lille, i	M	46	R	Middle and inner end, 1st and 2d ribs	7 months	Size of an orange	Total resection	Subperiosteal; encapsulated	Recovery		
45	Besson	1898	Ibid.	M	39	R	External end	7 months	Size of an egg	Total excision	Myeloid; periosteal	.....	.....	Operated on 9 years before for sarcoma of superior maxillary
46	Flament	1898	Ibid., ii	M	10	R	External two-thirds	1 month	Size of an egg	Resection of external two-thirds	.....	Recovery	Well 1 month	
47	Bourg	1902	Paris Thesis	M	45	R	Middle and inner end	2 years	Size of an orange	Total resection				

No.	Reporter.	Date.	Reference.	Sex.	Age.	Side.	Site.	Duration.	Description	Operation.	Type.	Result.	Final report.	Remarks.
48	Jonnesco	1903	Bull. et Mem. Soc. de Chir. de Bucarest, vi, 253	..	..	L	.....	.....	.....	Total resection	Osteo.	Recovery		
49	Degonville	1904	Paris Thesis	M	50	L	Middle third	2 years	.....	.....	Myeloid and round cell	.....	.....	Fracture; multiple fractures of ribs; died before operation; weighed when removed 1600 grams
50	Kryukoff	1904	Russk. Vrach., St. Petersburg, iii, 775	F	12	R	.....	.....	.....	Total resection	Round cell	.....		
51	Buteanu	1905	Bull. Soc. de Med., et Nat. de Jassey, xix.	..	..	..	.....	.....	.....	.....	Osteo.			
52	Coley	1909	Unpublished	M	16	L	Middle portion, myelogenous, round-celled	6 weeks	Size of an English walnut	Total resection followed by toxins	Periosteal	Recovery	Well at present, 1910; one year later	Toxins almost immediately after operation
53	Huntington, Thos. W.	1908	Unpublished	M	39	R	Outer and middle third	2 years	English walnut in size	Total resection followed by toxins (Coley)	Spindle-celled periosteal	Recovery	Well 2 years	Followed a blow
54	Gilbert Barling, Birmingham, Eng.; personal communication	1889	Unpublished	M	33	..	Inner half	Several months	.....	Resection	Spindle-celled	.....	Died on 4th day from suppuration of mediastinum and pleurisy	Fracture through middle of bone
55	Ibid.	1901	Unpublished	F	10	L	Middle and inner portion	.....	.....	Total excision	.....	.....	Recurred 9 months after, in scar; died a few months later	

56	Richardson, M. H.; personal communication	1908	Unpublished	M	34	L	Middle and inner third	4 months	.....	Total excision followed by toxins (Coley)	Small, round-celled	Recovery	Well 2 years and 2 mos.	Plank fell over striking patient on left clavicle
57	Hartley, Frank	1909	Unpublished	M	19	L	.....	2 years	.....	Total excision	.....	Recovery	Recurred in 3 months in side of chest	Toxins then used; temporary; unimproved only
58	Keen, W. W.	1898	Unpublished	M	21	..	.....	.....	.....	First operation partial; second, interscapular thoracic amputation; toxins	.....	Recovery	Died 8 mos. later, from recurrence	
59	Bodine (Coley)	1906	Unpublished	M	8	R	.....	3 months	.....	First, lancing of abscess; second, partial removal of tumor	Periosteal; round-celled	.....	Death in a few months	Received blow Oct., 1905
60	Warren, J. Collins (Coley)	1902	Unpublished	M	46	L	.....	6 months	.....	No operation; toxins; X-ray	Periosteal; round-celled	.....	Died 1 year later	Trauma; dislocation of shoulder
61	L. I. College Hospital	1909	Unpublished	M	38	L	Inner third	1 week	.....	Operation (?) Partial removal	Rapid growth	Recurrence week later in suprasternal fossa; toxins then given with but little benefit	.....	Strained shoulder
62	Stewart (Coley)	1910	Unpublished	M	20	L	Outer third	2 months	Tumor size of English walnut, outer end of clavicle	Operation; Dr. Stewart, Newport, R. I., March, 1910	Periosteal; round-celled	Recurrence 3 weeks; very rapid growth	Mixed toxins (Coley) Sept. 15, to Oct. 15, 1910; no effect on very large tumor	No single trauma, but habitually carried iron pipes and heavy material on left shoulder
63	Coley	1898	Unpublished	M	31	R	Outer end	9 months	Tumor of enormous size	General condition very bad; prognosis, few weeks of life				

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TRANSGASTRIC EXCISION OF CALLOUSED ULCER OF THE POSTERIOR WALL OF THE BODY OF THE STOMACH.

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GASTROJEJUNOSTOMY has proved an efficient means of relief for calloused ulcers which lie in the pyloric end of the stomach and are obstructive in character; but for the considerable number of cases in which the ulcer is located at some little distance proximal to the pylorus, this operation is often inefficient, and, at best, gastrojejunostomy leaves a cancer possibility which cannot be ignored.

It has been shown by Robson, Moynihan, and others, that gastrojejunostomy, though it gives relief to symptoms, does not protect the patient from later carcinomatous degeneration.

Three hundred resections have been performed in St. Mary's Hospital (Sept. 23, 1910). Two hundred and sixty-three of this number were subjected to careful examination in order to determine in how many of the cases cancer had its origin in ulcer, and it was shown definitely that 71 per cent. of the gastric cancers had developed on gastric ulcer.

The frequency with which malignant disease develops upon gastric ulcer leads to the conviction that chronic calloused ulcer of the stomach is treated best by excision, and in excising, if mechanical conditions are created which interfere with the progress of food, gastrojejunostomy for the purpose of drainage should be done as a supplementary procedure.

For ulcers lying in the pyloric end of the stomach, the Rodman operation is efficient, *i.e.*, partial gastrectomy with complete closure of the end of the duodenum and stump of the stomach, and independent gastrojejunostomy. This procedure is a rational application to a new field of the

Billroth operation number two for gastric cancer, and we have used the method a number of times with great satisfaction.

In saddle ulcers of the lesser curvature, excision may ordinarily be performed without difficulty, and the excision of an ulcer of the anterior wall of the stomach may be easily accomplished, but in the type of ulcers which occur on the posterior wall of the body of the stomach, which are so often adherent to the pancreas and other retrogastric structures, excision is most difficult. In several instances where there was hour-glass contraction, we have succeeded in making a resection in continuity with end-to-end anastomosis of the divided stomach ends.

There are a number of posterior ulcers, however, in which none of these operative measures can be applied satisfactorily, and in such cases we have succeeded in making a transgastric excision of the ulcer through the anterior wall of the stomach. Our first transgastric excision of a calloused ulcer of the posterior wall of the body of the stomach was the result of an immediate necessity to meet an accidental complication. A male, forty-eight years of age, was found to have calloused ulcer of the posterior wall of the stomach about four and one-half inches above the pylorus. The ulcer was adherent to the pancreas, which formed the ulcer base. An opening was made through the gastrohepatic omentum, and an attempt made to separate the ulcer from the pancreas, hoping thus to bring it into view through the opening in the gastrohepatic omentum and excise it, or to perform a resection in continuity. These manipulations resulted in partially separating the ulcerated surface posteriorly, with immediate leakage of the stomach contents behind into the lesser cavity of the peritoneum. The gastric opening was plugged with a finger, the gastrocolic omentum opened below, and with some difficulty adequate protection was secured about the ulcer. It was impossible to get a view of the ulcer either from above or below, therefore the anterior wall of the stomach was opened to the extent of three and one-half

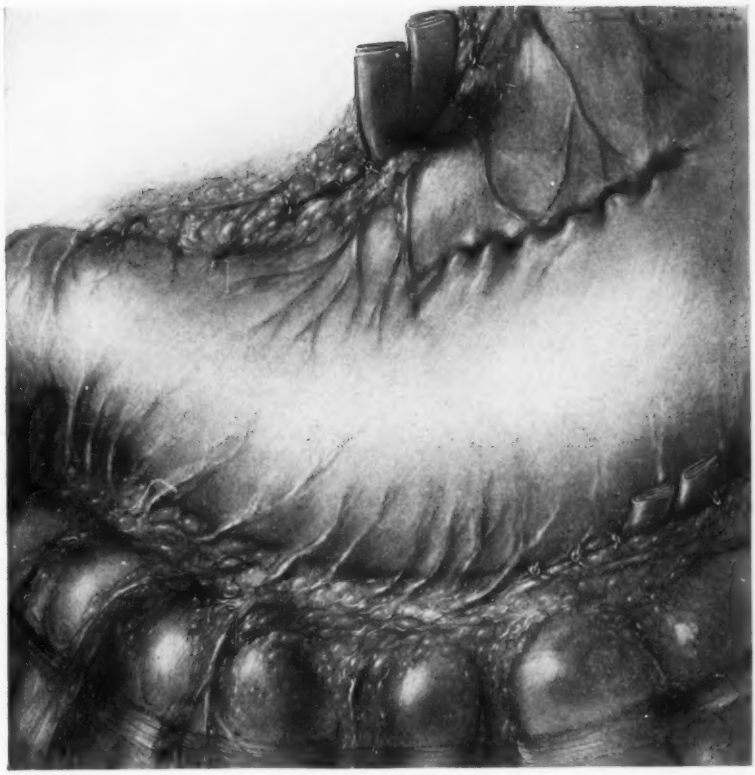
FIG. 1.

Transgastric excision of calloused ulcer of the posterior wall of the body of the stomach, showing anterior wall of the stomach open and the ulcer exposed. The dotted lines show proposed site of excision.

FIG. 2.

Ulcer excised, and the through-and-through mucous suture partially completed.

FIG. 3.



Anterior wall of the stomach sutured. Rubber-tissue drains in place.

inches in its long axis, and by retraction of the margins of the opening, a splendid view of the ulcer was obtained. The ulcer was excised with a knife, leaving it attached to the pancreas, from which situation it was shaved cleanly off. The cut margins of the posterior wall of the stomach were sutured from the mucous side by means of a running suture of heavy linen thread applied transversely to the long axis of the gastric cavity. The anterior wall of the stomach was closed with chromic catgut and linen. An attempt was then made to apply a peritoneal suture behind to cover the row which had been applied from the mucous surface. It was quickly seen, however, that serious damage would result in an attempt to secure the necessary exposure. Further examination revealed that the single through-and-through suture which had been applied from the mucous surface made a most satisfactory union without reinforcement. Three drains, composed of rolls of rubber tissue, were passed behind the stomach to the line of sutures to cover the site on the pancreas where the ulcer had been excised. These drains were brought out through the upper angle of the abdominal incision. There was no leakage or drainage, and the patient made a prompt and permanent recovery.

Connell, Coffey, and others have proved, clinically and experimentally, that the single suture is safe, and in the various instances in which we have applied the single through-and-through suture from the mucous surface, the result has been satisfactory.

We have performed the transgastric operation for removal of adherent calloused ulcers of the posterior wall of the body of the stomach five times, without leakage or evidences of infection, and with the recovery of the patient in each instance. The steps of the operation are as follows:

The gastrohepatic and gastrocolic omenta are opened above and below the ulcer. Gauze protection is introduced, adhesions are carefully separated, and, if possible, the ulcer surface is cut free from the posterior attachments without opening the stomach. A piece of gauze is packed into the

denuded area behind, and in all but one of our cases this temporary pack was adequate to stop hemorrhage without the ligation of vessels. The anterior wall of the stomach is opened, and with the fingers behind, the entire ulcerated surface is pressed through the anterior incision and the ulcer excised (Fig. 1). The gap is sutured with through-and-through sutures of chromic catgut from the mucous side transversely, and this suture line is further protected by several mattress sutures of linen, applied from the mucous side to prevent separation due to the early absorption of the catgut (Fig. 2). The anterior wall of the stomach is then closed. Several rubber-tissue drains are carried down behind the stomach and brought out at the upper end of the abdominal wound as a safeguard (Fig. 3).

NOTE.—Dr. Lewis S. Pilcher informed me recently that in May, 1907, he made a transgastric excision of the posterior wall of the stomach in a similar manner, with a successful outcome. A report of the case was published in the *Long Island Medical Journal* of May, 1908, p. 187.

RELATION BETWEEN APPENDICITIS AND DISTURBANCE IN THE GASTRO-DUODENO-HEPATICO-PANCREATIC PHYSIOLOGICAL SYSTEM.

A REPORT ON THE EXAMINATION OF 5000 APPENDICES WITH A COMPARATIVE STUDY OF THE PATHOLOGY AND CLINICAL HISTORIES IN 2000 CASES.

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THE possibility of an etiological relationship between the appendix and pathological conditions in the stomach, duodenum, liver, bile passages, and pancreas arose as the result of an investigation of the embryology, anatomy, and physiology of these organs in view of clinical experience and pathologic findings in studying the material from 216 gastrectomies,[1] 365 cholecystectomies,[2] 5000 appendectomies,[3] three duodenal ulcers[2] (autopsy), and the experimental experience of Cannon,[4] Litthauer,[5] Tsunoda,[6] Roger,[7] and others, all of which, when taken together, strongly suggest that the appendix is at least a part of the etiology of conditions which have been and are being treated as local conditions but which may possibly arise secondarily.

The material for this investigation was furnished by the clinics of Drs. C. H. and W. J. Mayo, and E. S. Judd, St. Mary's Hospital, Rochester, Minnesota.

Embryology teaches us that the stomach, duodenum, liver, gall-bladder, and pancreas are developed from a small segment of the primitive alimentary tract, and that the parenchyma of these organs as well as the stroma, nerves, lymph- and blood-vessels are derived from these structures in the primitive digestive tract.

Anatomy reveals the same blood and nerve supply for these organs that existed when they were a part of the simple primitive tube.

Physiology demonstrates the remaining necessity for products of digestion to pass in contact with the same alimentary cells (now the liver and pancreas) with which they came in contact in the primitive individual.

Autopsy has shown that duodenal ulcers when they occur at or near the papilla of Vater are sometimes, if not always, associated with cholecystitis, and occasionally with chronic interstitial hepatitis (cirrhosis).

The first case, No. 27,238, was a male aged 60 years, who was operated upon for cholecystitis seventeen months before the last operation. He was improved for five or six months, and again had epigastric pain, jaundice, and vomiting. At the second operation, which was performed at St. Mary's Hospital, the gall-bladder was found distended, the common duct dilated, and the head of the pancreas very hard. A note at operation stated that, if a third operation should be necessary it should be cholecyst-enterostomy. The patient died on the twelfth day after operation. Post-mortem examination revealed a marked cirrhosis of the liver, chronic catarrhal cholecystitis (strawberry gall-bladder), chronic pancreatitis, chronic congestion of the spleen, and a chronic ulcer of the duodenum at the ampulla of Vater, about 1 cm. in diameter. There was almost complete stenosis of the common duct in the base of the ulcer.

The second case, No. 31,049, was a male, aged 58 years, who, four years before examination, had attacks of severe epigastric pain which radiated to the back. Seven weeks before the last operation he had similar attacks accompanied by vomiting. At operation the gall-bladder was drained for cholecystitis with one stone, and a hard mass was felt at the end of the common duct, which was thought to be carcinoma of the head of the pancreas. On the fourth day after the operation the patient died from a hemorrhage into the bowel, associated with tarry stools and hæmatemesis. At autopsy a duodenal ulcer 2 cm. in diameter was found. The lumen of the common duct extended apparently unobstructed through the base of the ulcer.

The third case, No. 31,501, a male, aged 56, had his first

attack of pain in the epigastrium three months before examination. The pain was referred to the right costal arch. A week later he had severe pain in the same region. This was accompanied by slight jaundice, no vomiting, but fever and constipation. He suffered from gas belching, bloating, and headaches. At operation a large stone was removed from the neck of the gall-bladder, which it obstructed. The patient had a fatal hemorrhage into the bowel. At autopsy an ulcer of the duodenum was found.

Clinical experience presents strong evidence that there are gastric disturbances which are relieved and often completely dissipated by the removal of the appendix.[8]

Experimental physiology and pathology demonstrate that partial obstruction of the common duct is followed by cirrhosis of the liver;[6] and that irritants in the large bowel cause retardation of the muscular rhythm of the stomach and intestines;[4] and that experimental gastric ulcers which do not heal can be produced by trauma plus anæmia but not by trauma alone.[5]

Examination of the appendices removed in association with "pyloric spasm,"* gastric and duodenal ulcers, cholecystitis and cholelithiasis shows that there is a higher percentage of appendices with partially or completely obliterated lumina† in all of these conditions, than at general autopsy or at operation for appendicitis.

Specimens examined at autopsy and operation showed the following percentages:

Autopsy in	2549 cases,*	17 per cent. partially or completely obliterated
Pyloric spasm	17 cases,	17 per cent. partially or completely obliterated

* "Pyloric spasm" has been used clinically to denote an indefinite, apparently functional disturbance in the stomach evidenced by indigestion, pain, bloating, and dyspepsia.

† Obliteration of the lumen of the appendix is practically universally accepted by pathologists to-day to be the result of a mild or acute inflammatory process. The increase in the percentage of the obliterated or partially obliterated lumina does not increase gradually with the increasing decade. The greatest increase and the greatest activity in the process occur during the period in which appendicitis is most common.[9]

Appendicitis	1005 cases,	23.5 per cent. partially or completely obliterated
Gastric and duodenal ulcers	52 cases,	26.9 per cent. partially or completely obliterated
Cholecystitis	57 cases,	52 per cent. partially or completely obliterated
Cholelithiasis	118 cases,	44.8 per cent. partially or completely obliterated

In the previous studies [2] it was found that 23.2 per cent. of 365 cases in which cholecystectomy was performed showed symptoms which began at or under twenty-five years of age, the period during which appendicitis is most common, and that 13 per cent. of these cases gave definite histories of pain and soreness in the region of the appendix. In 59 of these cases of cholecystitis the appendices were removed, and 69 per cent. showed undoubted gross or microscopical evidence of inflammation, varying from a chronic catarrhal condition to complete obliteration and periappendicitis.

In the examination of 2000 appendices with their histories, 52 per cent. of 175 cases of cholecystitis with and without stones gave histories of pain in the region of the appendix.

In 1147 histories, which include all the cases of appendicitis and appendices removed during operations for conditions other than cholecystitis with or without stones, there was a history of pain in the epigastrium or right hypochondrium in 13 per cent. In 9.4 per cent. there was pain in the "abdomen" and in 14.6 per cent. pain in the "abdomen which radiated to and became localized in the region of the appendix."

The ages of patients at onset of symptoms of appendicitis, pyloric spasm, duodenal ulcer, gastric ulcer, cholecystitis, and cholelithiasis are as follows: 23.5 (1005 cases), 24.2 (18 cases), 31 (30 cases), 35 (10 cases), 34.7, and 33.8 years respectively. These conditions come to operation in the same order at the ages of 25.5, 34, 41, 48, 39.6, and 39.9 years. This order is exceedingly important if subsequent observations on a larger series of cases confirm it.

It is the rational course of events to be expected upon the hypothesis that irritation in the appendix and cæcum reflexly cause gastric and duodenal disturbances, which in turn interfere with the mechanism of secretion, storage, and outflow

of the bile, thereby producing conditions favorable for bacterial infection in these organs and the gall-bladder.

A consideration of the average duration from the onset of symptoms to operation, in appendicitis, cholecystitis, and cholelithiasis, reveals respectively 2, 4.9, and 6.5 years. It will be seen that the average duration in cases of cholecystitis lies between the average in appendicitis and cholelithiasis.

The question arises, is this a mere coincidence especially when we know that simple cholecystitis precedes gall-stones? Is there any relationship between these conditions? Are we dealing with a process which manifests itself in three stages, namely, appendicitis, simple cholecystitis, and cholecystitis with stones?

The average age at the onset of symptoms in these three conditions is also of interest, although there is not the same parallel. In appendicitis it is 23.5 years, in cholecystitis 34.7 years, and in cholelithiasis is 33.8 years. There is one thing to be considered, however, and that is the fact that the symptoms in cholelithiasis are likely to be more sudden and severe and therefore demand earlier attention than in simple cholecystitis.

There is a marked contrast between the percentage of appendices with partially or completely obliterated lumina at general autopsies and at operations for appendicitis, and that found in appendices which have been removed in association with cholecystitis and cholelithiasis. Twenty-three and five-tenths per cent. at operation, 17 per cent. at autopsy, and 52 per cent. in association with inflammation of the gall-bladder, have partially or completely obliterated lumen. Eight and seven-tenths per cent. of 2000 appendices were associated with cholecystitis.

In spite of the fact that a higher percentage of males were operated upon for appendicitis than females (55.5 per cent. males and 44.5 per cent. females), partial obliteration of the lumen occurred more often in females (55.2 per cent. females and 44.3 per cent. males). This may be one of the coincidents which lead to false deductions in all statistics, but the

figures are sufficiently significant to be kept in mind as possible evidence of the probable fact that the inflammatory processes in the appendix cause disturbances in the bile passages directly or indirectly, in view of the fact that cholecystitis is decidedly more frequent in females than in males.

These figures, which are the result of examination of the histories and specimens of 2000 cases in which the appendix was removed for appendicitis primarily or secondarily to other abdominal conditions, are sufficiently important, not to prove, but to stimulate, a careful study of clinical histories with relation to the possibility that chronic inflammation in the appendix reflexly disturbs the gastro-duodeno-hepatico-pancreatic physiological system, thereby bringing about conditions whereby such lesions as gastric ulcer, gastric carcinoma, duodenal ulcer, cirrhosis, cholecystitis, cholelithiasis, and pancreatitis may be indirectly produced.

During the examination of histories and surgical reports of upper abdominal conditions in which a high percentage of appendices had obliterated or partially obliterated lumina, it was thought that perhaps the technical difficulties in removal of an appendix through a high incision might influence the percentage, in view of the surgeon's ability to recognize such pathologic lesions in the appendix by palpation more readily than less extensive conditions. With this possibility in view, all of the upper abdominal conditions which were not apparently gall-bladder conditions were studied with the following results. In this series there were 46 upper abdominal incisions with 15 (32 per cent.) partially or completely obliterated appendices. For comparison those cases of lower abdominal incisions were taken and in 223 cases, 85 (38 per cent.) appendices were partially or completely obliterated. In 275 cases in which the stomach, duodenum, gall-bladder, and pancreas were explored and reported negative through the lower abdominal incision (straight or muscle splitting), 99 (36 per cent.) of the appendices were either partially or completely obliterated. In all of the upper abdominal conditions examined through high incisions and in the cases reported

negative through low incisions, there were apparently symptoms in the epigastrium which required investigation.

This is merely more clinical evidence that individuals who present a higher percentage of obliterated or partially obliterated appendices at operation do have symptoms referable to the epigastrium, and that the percentage is lower when no recognizable pathologic lesion was found than in cases in which definite changes were found. They are all suggestive enough to demand further experimental evidence upon the subject, and until they are disproven the surgeon should remove the appendix in all cases of chronic appendicitis and in association with lesions in the gastro-duodeno-hepatico-pancreatic physiological system when such an operation can be done with little or no extra risk to the patient. During laparotomies the appendix should be removed when such procedure does not materially add risk to the operation.

By this means there is a great possibility of reducing the number of lesions in that physiological system.

A careful study of the subsequent histories of all cases operated upon for appendicitis should be made in order to determine what percentage of them have developed gastric ulcer, gastric carcinoma, cholecystitis, cholelithiasis, cirrhosis, and pancreatitis.

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THE TECHNIC OF APPENDICOSTOMY.*

A CONSIDERATION OF THE PRESERVATION OF THE BLOOD SUPPLY OF THE APPENDIX IN THE OPERATION.

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SINCE Weir, in 1902, first ingeniously utilized the appendix for the purpose of irrigating the colon, the operation of appendicostomy has undergone many changes of technic.

The steps in the ideal, which is also fortunately the average case, are:

(*a*) Abdominal incision, preferably the intermuscular of McBurney.

(*b*) Turning out the appendix, and, when necessary, straightening it by releasing its mesentery while preserving its vascular supply intact.

(*c*) Suture of the cæcum adjacent to the appendix to the parietal peritoneum, carefully avoiding obliteration of any cæcal vessels.

(*d*) Closure of wound about the appendix.

I wish to emphasize the importance of steps *b* and *c* inasmuch as I had the misfortune of having the appendix slough in one of my cases which is detailed below. Moreover, upon inquiry I found that my experience was not unique, but that several colleagues had had a similar experience.

Mrs. X., age forty, weight 240 pounds. Health always good except for an attack of dysentery eight years ago. During the month prior to consulting me she suffered from severe diarrhœa, the dejecta gradually assuming a bloody character, and were accompanied by severe cramps and tenesmus.

Examination was difficult. Through the proctoscope the sig-

* Read before the American Proctologic Society, June, 1910.

moid prolapsed markedly, was ulcerated, and bled freely. No amœba were found. In spite of rest in bed, suitable hygiene, constitutional and local treatment over a period of three weeks, the patient did not improve and appendicostomy was proposed and accepted. I operated at the New York Polyclinic Hospital, March 21, 1908. The gridiron incision was employed, the meso-appendix tied off in part, and the cæcum at the base of the appendix sutured to the parietal peritoneum. While doing this the needle accidentally punctured one of the cæcal arteries going to the appendix and it was tied. The wound was closed in the usual way. Three days later the appendix sloughed, and after a septic temperature of ten days a large mass of fascia came away. Convalescence was uneventful from that time, but the two inevitable sequelæ followed, viz., fecal fistula and hernia. The former closed in due time, but the latter still requires an abdominal belt. The colon yielded to irrigations through the fistula and the patient is well to-day except for the hernia which cannot easily be repaired because of the loss of fascia and the obesity of the patient.

This experience stimulated the writer to a study of the circulation of the appendix from the surgical stand-point. To gain a comprehensive idea of the appendix as of any other part of the intestinal tract, one must refer to embryology.

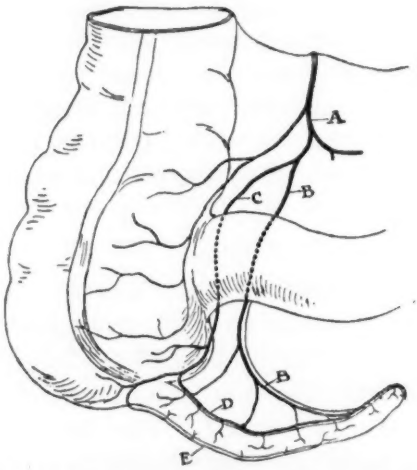
According to Huntington,[1] "The differentiation of the small from the large intestine, marked by the appearance of the cæcal bud or protrusion, takes place in the ascending segment of the umbilical loop a short distance from the apex. In the human embryo the cæcal bud appears in the sixth week as a plainly marked protuberance, which grows very slowly in length and circumference. It shows very early an unequal rate of development; the terminal piece not keeping pace in growth with the proximal portion is converted into the vermiform appendix, while the proximal segment develops into the cæcum proper."

Minot [2] states that "At six months the appendix is long and slender, *with a narrow free mesentery,* and is relatively much better developed than in the adult and is also less sharply marked off from the cæcum proper."

Briefly, then, the appendix is the vestige of the original head of the cæcum which failed to participate equally in development with the rest of that organ, and at a period prior to the sixth month of embryonal life, not possessing a mesentery, derived its sole blood supply from the cæcal vessels. The latter statement also holds true for the rudimentary and fetal forms of appendix, even in adults.

The vascular supply of the appendix is usually as follows: the descending branch of the colica dextra forms an anas-

FIG. 1.



A, posterior ileocæcal artery (partly schematic); *B*, appendicular branch; *C*, cæcal branch; *D*, constant, and *E*, variable branches from cæcal to appendix.

tomosing loop with the ascending branch of the ileocolic. From this loop the anterior and posterior ileocæcal arteries spring and are so named from their relation to the ileum. The former supplies the anterior surface of the ileum and lower cæcum but sends no branch to the appendix.[3] The posterior ileocæcal artery (see Fig. 1) passes back of the ileum close to the cæcum, and sends branches to ileum, lower colon, posterior cæcum, and appendix. The appendicular branch comes off from the posterior ileocæcal near its origin. The cæcal branch courses over the inner and back wall of the cæcum close to the appendix, to which it sends one or more branches.

These two branches, then, of the posterior ileocæcal, viz., the appendicular and the cæcal, are for all practical purposes the sole blood supply of the vermiform appendix.

Parenthetically it must be remarked that the so-called ligament of Clido, the occurrence of which is denied by many anatomists and surgeons, but which according to that author exists in 10 per cent. of women, is a negligible quantity in connection with appendicostomy, since the appendicular artery which it is supposed to contain anastomoses with mesenteriolar-appendicular branches.

The branch from the cæcal above noted is constant and courses along the appendix on its mesenteric side, anastomosing with branches of the appendicular, while occasionally a smaller branch runs beneath the peritoneum opposite the attachment of the mesentery.

The appendicular artery divides into several mesenteric branches, usually three to five, of which the largest runs in the free border of the meso-appendix. It is for this reason that perforation is apt to occur where the mesentery ends from gangrene of the tip beyond this point.[4] In a number of dissections made by the writer on injected subjects this arrangement of vessels was found regularly. These observations are in accord with the statement of Poirier, Charpy, and Cuneo[5] viz.: "It is to be noted that this last artery (the appendicular) has slight anastomoses only with the cæcal arteries; it is almost terminal and its obliteration should involve the necrosis of the appendix."

Remembering, then, that the cæcal branch is the earliest and a constant source of blood supply to the appendix, and that the mesenteric branch is the more abundant in nearly all adults, also that the anastomosis between these vessels is very limited, they being somewhat terminal in character, the precarious nature of the arterial stream to the appendix became evident at once as well as the importance of not interrupting the current of either the cæcal or the mesenteric branch at operation if the vitality of the appendix is to be maintained entire. In a given case where the anastomosis is unusually free, either branch

might be tied without danger, but at operation this point cannot be determined accurately, so the only safe clinical rule in practice is to respect and preserve both vessels.

At operation when uniting the cæcum adjacent to the base of the appendix to the parietal peritoneum, no difficulties are presented in avoiding the cæcal branches, as, fortunately, these vessels indicate their position by visible pulsation.

The mesenteric branches, however, require separate consideration. In some instances the appendix is so straight and the mesentery so narrow that it can be fixed in the wound at once. Most appendices, however, are falciform, as the mesentery is shorter than the appendix. To render their lumen fairly straight for the irrigating tube, it is necessary to free the mesentery. There are two ways of accomplishing this. One is to ligate and cut the mesentery at a point sufficiently distal from the base of the appendix that the blood supply is preserved to that portion of the appendix which traverses the abdominal wall. This method insures a viable organ up to the skin surface, but is open to the objection that the tip becomes gangrenous early and infection is apt to extend between the appendix and abdominal wound.

The other method, which is the one here advocated and in practice found free from objections, allows the appendix to be straightened sufficiently while preserving the vessels intact. Dr. Tuttle has applied this method in all his recent cases with marked success. It is accomplished by separating the two layers of the mesentery at its juncture with the posterior mural peritoneum, beginning at its free border, and carefully displacing the cellular tissue with its contained appendicular artery and branches as far as necessary toward the appendix. The two layers of peritoneum are divided transversely up to the base of the appendix, turned in, and sewed to obliterate the raw space on the posterior abdominal wall. It is unnecessary to test at once the patency of the lumen as advocated by some surgeons. This step adds an element of danger from infection. However constricted the lumen at first, it readily dilates to sufficient size. The danger is not that the calibre will be too

small, but rather that it will be too large and leak fæces. Another great advantage of leaving the appendix intact till the wound has healed is that it may then be amputated about one centimetre from the skin, the teat-like prominence thus left giving easy entrance to the tube.

Further precautions are not to obliterate any arteries by ligatures, sutures, forceps, tension or torsion in fixing the appendix in a position where it does not rest naturally, or compression by closing the abdominal wound too snugly about it.

Bearing these points in mind, the operation of appendicostomy is on a par with an interval appendectomy as regards technic, speedy convalescence, and safety, the mortality being nil in my series of cases. Postoperative leakage of fæces and hernia, the two troublesome sequelæ of appendicostomy, are also avoided.

By practising this improved technic I am confident that results will be so satisfactory that appendicostomy will continue to grow in general favor over cæcostomy in all cases where prolonged irrigation of the entire colon is indicated.

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ANOMALOUS RENAL ARTERIES AND THEIR RELATION TO HYDRONEPHROSIS.

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THE following variations are reported with a two-fold object: first, to discuss in some detail the more common irregular types of the arterial supply to the kidney; second, to call attention to the relation of such variations to operative procedures on the kidney and their importance as a causal factor in the development of deformities of the pelvis and ureter.

The variations herein reported were found in subjects dissected in the Anatomical Laboratory of the University of North Dakota. Our records include too few subjects to attempt any statistical conclusions at present, but the following cases illustrate the more common types of variation.[1]

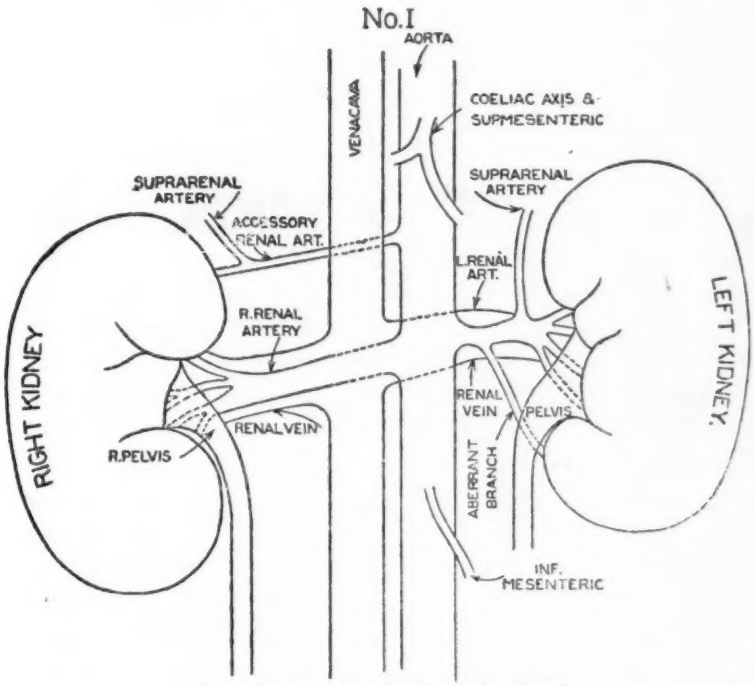
CASE I.—Adult female, dead of tertiary syphilis. Kidneys and genitals otherwise normal, arterial system also essentially normal except that the superior mesenteric comes off the cœliac axis. The suprarenal receives a superior branch from the inferior phrenic, no middle branch, and an inferior branch from the accessory renal on the right side and from the renal on the left side. As shown in the drawing, the variation represents two types. On the right side, a truly supernumerary branch comes off the aorta about 4 cm. above the renal, passes behind the vena cava, and enters directly into kidney substance at the upper pole. On the left side, the single renal artery gives off a branch close to the aorta which is about 6 mm. in diameter. This passes behind the ureter to the lower pole of the kidney, where it branches inside of the capsule.

CASE II.—Adult male, dead of tuberculosis. No other essential abnormalities. On the right side the arterial supply to the kidney is normal, but there are three distinct renal veins, all entering the hilum behind the pelvis. On the left side two arteries of equal size come off the aorta at the site of the renal. One gives off the inferior suprarenal and itself passes

[1] Since the preparation of this article a report has appeared in the *Journal of the American Medical Association*, by Drs. Eisendrath and Strauss, in which they give statistics on this subject from the Chicago dissecting rooms. These agree closely with those given by Quain and generally recognized by anatomists.

to the hilum, where it sends one branch behind the pelvis and two in front of it. A second branch, just above, crosses the first in front of the pelvis to the lower part of the hilum. A third branch is given off the aorta opposite the lower pole of the kidney, which it enters after passing in front of the ureter. These branches are of about equal size, fully that of the radial.

An examination of the endings of these anomalous branches indicates that they carry an important blood supply. In each instance the vessel gives off a considerable tuft of

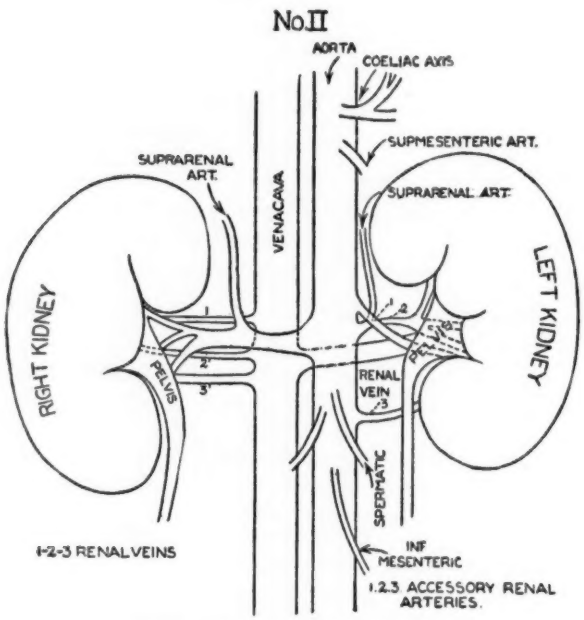


Anomalous renal arteries described in Case I.

branches inside the capsule. Injection material, ultramarine blue and shellac in methyl alcohol, was always found in these branches and in the neighboring tissue. I was unable to determine the relationship of these branches to the main supply at the hilum, and the literature at my disposal gives no additional light on the subject.

Our anatomical concepts are usually formed on the authority of some one or other of the standard texts. Such

pictures we are prone to apply to any and all subjects as constant structures. Even a limited experience in the dissecting room is sufficient to convince one that the standard type is often modified in important particulars. A study of the more common variations is nearly as important as that of the general type. Most of the better anatomical texts give ample descriptions and explanations of the more frequent abnormalities. The works on operative surgery, however, give little or no space to some of them at least.



Anomalous renal vessels described in Case II.

The accepted picture of the blood supply to the kidney is that of a paired renal artery, one to each kidney. Each artery divides, close to the kidney, into three or more branches, some passing in front of the pelvis and some behind. The pedicle consists of a single artery, vein, and ureter. Besides we may also think of several small arteries entering the capsule from the parietal branches. Variations of greater or less importance are described by anatomists as being present in

about 20 per cent. of all subjects. These may be considered under one of three types: 1. The renal artery, instead of being a single vessel from the aorta to the hilum may give one or more branches near the aorta. Such a branch may enter the hilum with the main blood supply or may enter at either pole of the kidney, and may pass either behind or in front of the ureter. 2. There may occur one or more true supernumerary renal arteries from the aorta, either above or below the main branch. This extra vessel also may enter the hilum or either pole of the kidney and may pass in front of or behind the ureter. Such a vessel is more common on the left side and above the main renal. According to Quain they are found in more than 3 per cent. of all cases and rarely four or more such branches occur. Accessory renal arteries of considerable size may come off from the parietal branches, inferior phrenic, or lumbar arteries, or from the spermatic or suprarenal vessels. These branches most frequently enter directly into kidney substance through the capsule. 3. When the kidneys are abnormal in position or shape, as horse-shoe kidney, etc., an abnormal blood supply is commonly found. The main arterial supply may come off the aorta as a single or multiple branch, above or near the bifurcation, from the inferior mesenteric, common or external iliac, or more often from the internal iliac artery.

Anatomically such variations are well recognized by such authors as Poirier, Sharpy, and Cuneo, Quain, Piersol, Gerrish, Sabotta-McMurrich, Treves, Deaver, and others. Practically they are of importance in two respects: first, as cause of unexpected hemorrhage complicating operations on the kidney; second, as a possible factor in the development of hydronephrosis, by causing pressure on the pelvis or ureter.

The frequency of such aberrant and abnormal vessels should be constantly in mind when operating on the kidney or ureter, and would seem to demand considerable attention in works devoted to operative surgery. Whenever the kidney is found abnormal in position or shape, aberrant and

accessory branches should be expected, either at the hilum or entering the capsule. With a normal kidney such vessels are more dangerous because usually unexpected. They may be obscured by adhesions and thus injured without knowledge of their presence, or may be missed in clamping or ligating the pedicle, thus being a possible source of serious hemorrhage. Accessory and abnormal renal veins are even more common than such arteries and are an occasional source of venous hemorrhage. Works on operative surgery give scant or no attention to such possibilities in describing operations on the kidney. White and Martin, Keyes, DaCosta, Fowler, Binnie, Bickham, "International Text-book," and Keen make no mention of the possibility. Bryant speaks of irregularity in the blood supply and gives an illustration showing an accessory renal artery entering the hilum. Jacobson and Steward, speaking of causes of death after nephrectomy, mention hemorrhage, where the pedicle is short and difficult to control or where there are aberrant renal vessels.

The relation of such aberrant vessels to dilation of the pelvis and ureter is a disputed one. Mayo[2] reports that in twenty-seven cases of hydronephrosis anomalous renal vessels were present in twenty, and an obstruction was found in the ureter at the site of its relation to the vessel. In thirteen of these cases simple division of the vessel in question was sufficient to relieve the condition. Seventy-five per cent. of these vessels passed in front of the ureter. Dr. McCarthy in the same journal gives some interesting drawings which show the relation of the abnormal artery and the dilated pelvis. Gardner[3] gives an exhaustive discussion of the subject of hydronephrosis, and considers the relationship of abnormal vessels in great detail. He cites three mechanisms by which such vessels may be presumed to cause hydronephrosis by compression of the pelvis or ureter: 1, intermittent pulsation of the artery; 2, continuous pressure by the vessel; 3, actual kinking of the ureter on such a vascular cord.

[2] Journal A. M. A., May 1, 1909.

[3] ANNALS OF SURGERY, October, 1908.

Dr. Gardner believes, however, that in many of the cases of hydronephrosis the aberrant vessel is not the primary cause of the condition. The drawings in both articles show a close relation between the vessel and the dilated ureter and pelvis. But they do not prove that the vessel caused pressure on a normal ureter, forming a stricture and dilatation. In fact, it is hard to see how such a vessel could affect a normal ureter or pelvis of a normal kidney in its usual position. Some go so far as to state that it is only because of the hydronephrosis that the vessel comes in relation with the ureter at all. There are, however, numerous cases of hydronephrosis where the aberrant vessel is the only apparent cause, and the relation must be recognized as one possibly of importance. One of three associated factors might be involved and with such a vessel lead to further changes in the pelvis or ureter. First, if there was a dilatation from any cause, such a vessel coming in relation to the dilated ureter might cause an angulation or stricture and represent the beginning of a hydronephrosis as shown in some of the drawings. Second, inflammatory adhesions about the pelvis or ureter might be a factor with an aberrant vessel in causing dilatation of the ureter above a stricture. Third, mobility of the kidney may become an important factor. In a simple nephroptosis the ureter might form a kink over an aberrant vessel passing behind it and a subsequent dilatation develop above such a point. This could hardly happen if the vessel were in front of the ureter unless the kidney were to fall forward over the vessel and rotate on its pedicle.

The embryological explanation is interesting though not absolute. Kollmann, McMurrich, and Piersol describe the mesonephros as a segmented structure receiving a series of arterial branches from the aorta. The permanent kidney develops about outgrowths from the upper end of the ureter in differentiated mesenchyme which gives rise to the glomeruli and vascular part of the kidney, at least. It is probable that this tissue also receives several branches from the aorta in the early stages of development, and that the

single renal artery is the result of fusion and obliteration of the extra branches. On such a basis it is easy to understand that variations as described simply represent an incomplete development, so that supernumerary vessels and high divisions of the renal must be very frequent. The truly aberrant vessels from the inferior mesenteric, spermatic, iliacs, etc., are doubtless explained as adaptation on account of abnormal position of the kidney and are a necessary accompaniment of such a condition.

THE ANATOMY AND TREATMENT OF UNDESCENDED TESTIS; WITH ESPECIAL REFERENCE TO THE BEVAN OPERATION.*

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THE quest of an efficient method of replacing the undescended testis within the scrotum has afforded abundant exercise for the ingenuity of surgeons, especially within the past decade or two. It is a barren year, indeed, when no new operation for undescended testis is published, and the galaxy of methods that we now possess is ample testimony that this field of surgery at least has not been neglected. This extraordinary inventive activity is in itself an indication of dissatisfaction with the methods previously recommended, and my own experience corroborates this entirely. Up to within a few years I tried nearly all methods that appeared to me to be rational, but when I viewed my ultimate results, my feelings never even approached that of satisfaction. Since then, however, my experience with the Bevan operation in eighteen cases has given me results so immeasurably superior, that, from my point of view, a satisfactory operation for undescended testis has at last been attained.

This operation involves so many anatomical and physiological problems, that I shall survey these before reporting to you my clinical experiences.

The cause of the descent of the testis is a matter of academic importance, and I therefore shall refrain from discussing it at length. Moreover, there is even now no unanimity upon the matter. Of far greater importance is a correct knowledge of the anatomy of the imperfectly descended testis.

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* Read before the New York Surgical Society, October 12, 1910.

ANATOMICAL VARIETIES.

Before I enter into a description of the anatomy of the parts in question, I must digress somewhat, in order to give a clearer definition of the abnormality under discussion. As will be seen, there are a number of varieties, and the anatomy of the parts is modified to a certain degree by the particular anomaly.

I. NON-DESCENT.—Without going at length into embryological details, I would merely recall to you, that the primary genital anlage is placed in close proximity to the kidney, and before reaching its ultimate resting place in the scrotum it must pass along the posterior abdominal parietes and through the inguinal canal and upper parts of the scrotum. The testis may be arrested in any part of its course, and in consequence we may have the following anomalies:

1. *The abdominal non-descended testis.* The testis is arrested proximally to the internal inguinal ring.

2. *The inguinal non-descended testis.* The testis is arrested in the inguinal canal.

3. *The pubic non-descended testis.* The testis is arrested just distally to the external inguinal ring, *i.e.*, in front of the pubis.

4. *The upper scrotal non-descended testis.* The testis is arrested in the upper part of the scrotum.

II. MALDESCENT.—This variety differs from the preceding one in the important fact that the testis is not arrested anywhere in its course. The organ is extruded through the external inguinal ring, just like a normal testis; at this point, however, it fails to take its proper course into the scrotum and is deflected into other directions. When this occurs we may have the following three types of maldescent:

1. *The inguinosuperficial maldescended testis.* The testis, after its extrusion from the external inguinal ring, is deflected upwards and outwards, so as to lie upon the aponeurosis of the external oblique, between it and the deep layer of the

superficial fascia. I have operated upon quite a number of this variety.

2. *The crural or cruroscrotal maldescended testis.* The testis lies in the upper part of Scarpa's triangle, or more frequently in the angle formed by the thigh and scrotum. Of this variety I have operated one case.

3. *The perineal maldescended testis,* in which the testis, after its extrusion from the inguinal canal, migrates into the perineum. I have seen two instances of this variety.

SURGICAL ANATOMY.

I have operated upon a considerable number of cases during the past twelve years, have made careful observations and notes in all, and shall endeavor to briefly place these before you. They have, I believe, a definite value, because they are not speculative; on the contrary, they are actual findings which bear very readily corroboration.

1. *The body of the testis* is usually small, at most from one-third to one-half as large as its corresponding fellow, or as large as it should be for the age of the affected individual. In consistency the organ is distinctly softer than normal, but it retains absolutely the so-called "testicular feeling." This feeling is very important in the diagnosis of the position of the testis, particularly when the anomaly is accompanied by a large omental hernia. In a great majority of the cases the testis has a distinct mesentery, allowing considerable mobility, particularly in a lateral direction.

2. *The epididymis* is, as a rule, well developed, but is not infrequently separated from the body of the testis.

3. *The vas deferens is always of ample length.* I cannot lay too great emphasis upon this point, because it has an important bearing upon the operative procedure. In fact, in many instances, the vas deferens is of unusual length and is found extending to the bottom of the scrotum, in the form of a loop, although the testis and epididymis may be situated within the inguinal canal or even within the abdomen.

In regard to this point, I would take emphatic exception to

a recent statement of Katzenstein,[1] that the failures of most operations for cryptorchismus are due to the fact that the very elastic and short vas deferens retracts the testis, after it has been anchored in the scrotum. He attempts to prove his theory by attaching weights to equal lengths of spermatic vessels and vas deferens, isolated from a spermatic cord. No one doubts that this experiment will prove the well-known greater elasticity and resistance of the vas; but it would be utterly fallacious to deduct from this experiment, either that the vas is too short or that it is the cause of failures after operation.

4. *The processus vaginalis* is, as a rule, in open communication with the general peritoneal cavity, thereby converting the sac into a precursor of a so-called " congenital " hernia. I ought to make this statement with some hesitation, because a colleague has told me of a case in which there was an undescended testis, with a perfect tunica vaginalis and no accompanying hernia. Personally I have, however, never seen such a condition.

The nearest approach to such a condition came under my observation recently. The testis was high up in the inguinal canal and was accompanied by a large hernia of the congenital type. There was another sac in the scrotum, which contained a moderate amount of clear serum; the upper sac was invaginated into the lower one. In other words, the hernia corresponded more to what is termed the " infantile " type.

In approximately one-half of the cases, particularly in those accompanied by large herniæ, the vaginal process extends to the bottom of the scrotum. I wish to lay emphasis upon the point, that in about one-half the cases the vaginal process does not extend to the bottom of the scrotum, because it indicates a divergence between the observations of the embryologist and of the surgeon. The embryologist claims that the testis is always preceded in its descent by an outgrowth or prolongation of the peritoneum into the scrotum. Were this the case, we should have no trouble in demonstrating this pro-

[1] Zentralblatt f. Chirurgie. No. 31, 1910.

longation in every case of undescended testis. As a matter of fact, we do not find it; at all events, I have never found it except in cases that are accompanied by a scrotal hernia of considerable dimensions. I believe that in these cases the prolongation was pushed to the bottom of the scrotum by the advancing hernia and was not a pre-existing entity.

Much stress has been laid by some surgeons upon the vaginal process as an obstacle to the bringing down of the testis at operation. I believe this theory is erroneous for the following reasons: (1) It does not take into consideration the different lengths of the sac. (2) The testis is in reality a retroperitoneal organ, and its motility cannot, therefore, be affected by something outside of it. (3) Even when the neck of the sac is freed and ligated, the testis is no nearer to the bottom of the scrotum than before. (4) The most practical of all, I have never found the sac to give me the slightest difficulty in mobilizing the testis.

The peritoneum forming the vaginal process, even when accompanied by old and large hernia, is exceedingly thin and delicate, requiring extremely careful and cautious dissection in order to liberate it.

5. *The spermatic cord* is not gathered into a normal cord-like structure, but is spread out fanshape over a considerable area. The vas, as a rule, lies somewhat isolated from the other component parts of the cord. The spreading out of the structures and the already mentioned thinness of the serous membrane make the dissection and freeing of the sac a step of unusual delicacy.

6. *The spermatic vessels* are poorly developed. Both the veins and the spermatic artery possess a smaller calibre than normal. When the spermatic artery is cut, the bleeding is slight, or at all events not nearly as free as in a normal case. I am also of the opinion that the small size and softness of the testis is due to this hypoplasia.

I now come to one of the most important observations in regard to the surgical anatomy of non-descended testis. It is this: ***the spermatic vessels are deficient in length,*** and appar-

ently by the distance between the testis and the bottom of the scrotum. Whether this shortness is due to a congenital hypoplasia, I am not prepared to say. It would also carry me into the realms of speculation were I to decide off hand the question, whether the non-descent of the testis is due to the shortness of the vessels or whether the shortness of the vessels is caused by the non-descent of the testis. Arguing by analogy, similar anomalies have been noted in malpositions of other organs, *e.g.*, malpositions of the kidney; and while I have no absolute proof, I am inclined, for want of a better theory, to assume that the non-descent is in a great measure due to the shortness of the spermatic vessels.

It is also needless to add that at this time I speak only of the undescended testis, for in the maldescended organ the blood-vessels are of sufficient size and length.

7. *The scrotum* varies in size; this variation, I have found, depends upon the presence or absence of a hernia. If no hernia is present, the scrotum is very small; but if a hernia is present, the scrotum is large, its size varying with the size of the hernia. Some writers lay considerable stress upon the non-development of the scrotum, both as a cause of the non-descent of the testis and as a cause of the inability to anchor the testis properly. I am positively of the belief that both these assumptions are erroneous; first, because the scrotum accommodates itself easily to any size, either by a hernia, or by the replacing of one testis, or by the replacing of even both testes; and second, because the embryological development of the scrotum is independent of that of the testes.

There is not much to say of the anatomy of the maldescended testis. The gross anatomy is like that of the normally descended testis. Exceptions are to be noted mainly in the regional anatomy. Very frequent also is the presence of a congenital hernia. Above all, it is to be recollected that the cord as a whole and integrally is never too short, and after being freed from the surrounding structures, there is never any difficulty in transplanting or retaining the testis in the bottom of the scrotum.

REASONS FOR OPERATING.

1. Every undescended testis is accompanied by a hernia, either actual or potential. Furthermore, in these herniæ, the application of a truss is either impossible or painful. The use of the forked truss has in my hands not proven serviceable.

2. The undescended testis is more subject to trauma than the normally situated testis.

3. It is important to remember that the testis possesses two functions: (*a*) the elaboration of spermatozoa, (*b*) the maintenance of sexual characteristics. In undescended testis the burden of belief seems to be that the spermatogenetic function is either totally absent or reduced to a minimum. This has been ably proven by Haines, who showed in a convincing study that in pigs, in whom undescended testes are very common, the spermatogenetic cells are all absent. On the other hand, he showed that the interstitial and Sertoli cells, which he believes bear important relations to the maintenance of sexual characteristics, are preserved and are enormously increased in number. The preservation of the second function is therefore a paramount indication for a conservative operation upon an undescended testis, especially in the young.

4. Although it is claimed by many that the replacement of the testis within the scrotum restores its spermatogenetic function, I have not been able to convince myself of this entirely. In one case, in which I replaced both testes, spermatozoa were absent both before and after operation. However, even the possibility that the spermatogenetic function may be restored is, to my mind, an indication for operation.

5. The not infrequently observed development of malignant tumors in non-descended testes should be considered as an indication for operation. I have seen one instance of this.

6. An undescended testis is peculiarly liable to certain accidents, which may frequently threaten and destroy its life. I refer particularly to torsion of its spermatic cord. I have operated upon three cases of this nature, in two of which I was compelled to ablate the testis at the primary operation; in

the third case I made an attempt to untwist the cord and preserve the testis, but was unsuccessful and had to ablate it at a second operation. De Quervain describes a peculiar accident in an undescended testis, by which either the body of the testis or its cord becomes strangulated by the pillars of the external ring. I have never seen a case of this nature.

7. Extension of a gonorrhœa to a scrotal testis or metastatic involvement in mumps is sufficiently distressing, but these conditions in an undescended testis are very grave and may even menace the patient's life.

8. A minor reason, perhaps, and yet not a negligible one, is the psychic depression under which adults suffer when only one, or worse still, when neither testis is in the scrotum.

There is no contraindication, except perhaps extreme youth. This, however, merely implies a postponement of the operation to a suitable age. Personally I have decided upon the age of three as the lowest limit, and postpone operation in all younger cases, unless forced to operation by strangulation or other accidents.

TREATMENT.

First of all, I wish to emphasize that I do not regard a case of undescended testis as cured unless the testis is at the lowest part of the scrotum. I have had shown to me cases of so-called "cure" of an undescended testis, in whom the testicle was sometimes even as high as the upper third of the scrotum or front of the pubis. To call such cases "cures" is, to my mind, an evidence of a deplorable sense of satisfaction.

In view of the fact that I successively tried nearly all methods of treatment that have been recommended, a short résumé of my experiences may perhaps prove of some value. I shall try to demonstrate why these methods have largely been failures in my hands, and why I have finally settled upon the Bevan operation as the most satisfactory of all.

1. One of the first methods of treatment for undescended testis was that advocated by Langenbeck. This consisted in massage, manipulations, and the application of a forked truss,

to prevent the testis from slipping back. I have tried this method faithfully in a number of cases, where for justifiable reasons I could not operate, but with the exception that the testicle may in favorable cases be retained outside of the inguinal canal, I have seen no benefits from this method. The truss causes much discomfort and retains the hernia but unsatisfactorily.

2. The objections to orchidectomy are so apparent that I shall not even mention them. I may add, that in former years I also was guilty of performing this operation.

3. Replacement of the testis within the abdomen, with closure of the internal inguinal ring, has been suggested and carried out. With the exception of the fact that it cures the hernia, I can see no advantage in this operation over non-interference, inasmuch as it exposes the testis to all the other dangers inherent to the non-descended organ, and is certainly not cosmetic.

4. On the theory that the non-descent of the testis was due to a shortness of the vas deferens, I attempted in one case to lengthen the vas by unravelling it from the epididymis. I have not looked up the literature upon this point and do not know whether anybody has tried it before or after me. The result was a complete failure. The theory, I have since learned, was based on a misconception, and I am now convinced, as I have said before, that the vas is always of ample length.

5. Schüller's operation.[2] Early in the study of the pathology of undescended testis, the presence of the open tunica vaginalis was regarded as the cause of the non-descent. The destruction of this peritoneal prolongation was therefore considered as imperative. As advised by Schüller, this was done by dividing the tunica at the internal inguinal ring, forming a new tunica vaginalis from the lower part, and anchoring the testis to the scrotum by sutures. This operation has in my hand succeeded in a small number of cases, but only in those in which the testis is already very close to the scrotum; in

[2] Zentralblatt für Chirurgie, 1881.

other words, in milder forms of the affection. In more aggravated cases, however, when even the slightest tension upon the cord becomes necessary, either one of two things happens: the testis tears loose from its anchorage in the scrotum and retracts to its original position; or if the anchorage holds, the scrotum gives way and is invaginated and pulled up by the retracting testis. In order to obviate this, the method has undergone numerous modifications.

(*a*) The fascial structures of the cord were sutured to the pillars of the external inguinal ring (Dowd, Kocher).

(*b*) The septum scroti was incised, and the undescended testis sutured to its fellow of the opposite side.

(*c*) The testis was anchored to the bottom of the scrotum by sutures passed through the latter, and tied over an external pledget of gauze.

(*d*) Lanz's operation.[3] Sutures were passed through the testis; these sutures were then passed through the scrotum, left long, and fastened to a wire cage or to thigh, or, according to some, even to the big toe; the idea being that the continuous traction will so lengthen the cord that upon removal of the sutures the testis will stay in the scrotum. Ingenious as this idea appears, I have seen two recurrences after this operation.

(*e*) A small incision is made in the bottom of the scrotum, through which the testis is extruded; the incision is closed snugly, leaving the testis outside, the idea being to leave it there until adhesions have formed, whereupon the incision is reopened and the testis replaced. The objections to this method are, (1) the dangers of infection, and (2) the uncertainty of the result.

(*f*) Starr[4] fastens the testis to a wire splint, which is fixed on one end to the pubic bone and at the other to the scrotum.

(*g*) Keetley-Torek. This operation is divided into many steps, consisting in a great measure of very delicate manipulations and complicated sutures. I shall not describe the operation in detail, but in essence it consists of the following steps:

[3] Zentralblatt für Chirurgie, 1905.

[4] ANNALS OF SURGERY, vol. xlviii.

The testis is liberated and the hernia corrected. An incision is then made in the bottom of the scrotum, through which the testis is extruded. At a properly selected place an incision is then made upon the thigh, down to the fascia; the testis is fastened to this structure, and the two lips of the scrotal incision are sutured to the two lips of the thigh incision. The principle of the operation consists in the belief that the fixation of the testis to the thigh lengthens the cord. At a second operation, from three months to a year later, the scrotum and testis are liberated from the thigh, and the testis replaced within the scrotum.

Excluding the technical difficulties, which, to my mind, are minimized by the originators of the operation, the operation possesses a number of objections. The postoperative course is not a very pleasant one for the patients; they object to the continuous dragging upon the testis; and after the wounds have healed, their gait is worse than awkward; they are troubled for a long time with a disagreeable eczema from the apposed skin surfaces, particularly in hot weather. The danger of infection is not small, and, finally, the necessity of performing two operations is not to be considered too lightly.

For the sake of completeness, I may add:

6. Beck's necktie operation,[5] which at best can only hold the testis outside of the external inguinal ring.

7. Kirschner's operation[6] was published this year, and only goes to prove that the possibilities are by no means exhausted. A sort of bell-shaped receptacle is made for the testicle, from a piece of the fascia lata of the patient (autoplastic), which is passed through a subcutaneous tunnel and is fastened to the superficial perineal fascia.

8. Bevan's operation.[7] When I read Bevan's original report, I was at first inclined to be sceptical, believing that the division of such important parts of the spermatic cord must surely result in gangrene of the testis. Bevan's report, how-

[5] N. Y. Medical Record, Aug. 12, 1905.
[6] Langenbeck's Archiv., vol. xcii, p. 906.
[7] Langenbeck's Archiv., vol. lxxii, p. 1035.

ever, was so reassuring, that I determined to try the operation. Since then I have never had occasion to regret my decision.

Before explaining to you the principles upon which the operation is based, I shall describe the operation in detail.

1. The cutaneous incision is like that for the radical cure of inguinal hernia. The aponeurosis of the external oblique is split in the direction of its fibres. Retraction of the lower flap exposes Poupart's ligament.

2. The hernial sac is now isolated and freed from the spermatic cord. It is advisable to begin the isolation of the sac at the neck; when this is done, the peritoneal cavity is closed, either by transfixion and ligation, or by circular suture. It is perhaps needless to add, that when the testis is intra-abdominal, it is essential to first open the sac and extract the testicle from the abdomen. I have never seen the occasionally described adhesions between the testis and the peritoneum, due, as some authors claim, to a fetal peritonitis, which in turn was supposed to cause the non-descent of the organ.

The distal part of the sac can be dealt with in three different ways: (*a*) it may be cut off close to its attachment to the testis; (*b*) it may be cut off at some distance from the testis, and a new tunica vaginalis formed; (*c*) it may be everted and sutured. I have used all three methods, and have obtained equally good results with all. I prefer the first method, because it saves time by not requiring any sutures.

In isolating the sac there is one very important point to be observed. The liberation of the vas deferens from the sac must be carried out with exceeding care. The vas deferens should never be handled roughly, and should certainly never be pinched with forceps. The ultimate viability of the testis depends, as will be shown later, upon the small artery of the vas, a branch of one of the vesicals, and if this should be injured or thrombosed there is a grave danger of necrosis of the testicle.

3. If the parts are now examined, there will be seen the vas deferens with its vessels, and the spermatic vessels, diverging as they enter the internal inguinal ring; the former going

downwards and inwards toward the bladder, the latter almost directly upwards and slightly inward.

The cord is now gauged as to whether or not it will permit transplantation. In minor degrees of non-descent, transplantation may be possible. If it is impossible to bring down the testis, traction upon the cord will readily show that the spermatic vessels become taut, and not the vas deferens.

In some instances freeing the vessels of all extrinsic fascial structures, by teasing and occasional snips with the scissors, will enable the testicle to be brought down. In most cases this will not suffice, and we have to proceed to the essential part of the Bevan operation, namely, the division and ligation of the spermatic vessels.

The moment this is done, it will be seen that no matter how high up the testis may have been situated, there is not the slightest difficulty in bringing the testis down to the very bottom of the scrotum, particularly if the vas is freed down to the epididymis.

4. The corresponding half of the scrotum is now stretched with the finger or dressing forceps, for the accommodation of the testis. There is never any trouble with this step, no matter how small and how shrunken the scrotum appears to be. Into the pocket thus formed the testicle is placed without any anchorage, and in order to prevent any possible luxation, the neck of the scrotum is closed around the vas by an interrupted or circular suture.

5. The radical operation for the hernia is now proceeded with, without any transplantation of the vas. In some instances I have adopted the Fowler operation, which diminishes the arc of the spermatic cord. In one instance I tried to gain space by liberating the deep epigastric vessels and slipping the testis behind the vessels, before transplanting the organ into the scrotum. I have found this, however, to be an unnecessary and bothersome refinement.

POSTOPERATIVE COURSE.

Not infrequently, on the second or third day after operation, there is more or less exudation around the testis. Whether

this is due to an infarction, or thrombosis, or to a diminished return flow, I am not able to say definitely, for the simple reason that I have never had occasion to reopen the wound. Under the application of a hot water bag, this exudation, however, quickly becomes absorbed. In my earlier cases I rather dreaded this œdema and feared interference with the blood supply, but I have now become accustomed to it.

RATIONALE OF BEVAN'S OPERATION.

Bevan devised his operation upon a correct knowledge of the blood supply of the testis, and upon the important discovery, as I have already emphasized, that the inability to bring the testis down into the scrotum was due to the shortness of the vessels of the cord.

For a long time it was assumed (Miflet[8]) that the spermatic artery is an end artery, and that it is the sole arterial supply of the testis. Recent investigations (Griffiths[9] and Hill[10]) have, however, shown that this is an error, and that the testis has an additional and very important blood supply, namely, the artery of the vas deferens, a branch usually of one of the vesical arteries.

In order to prove this to my own satisfaction, from a physiological view-point, I performed a series of experiments on dogs at the Pathological Laboratory of the College of Physicians and Surgeons, through the kindness of Professor MacCallum. I divided the spermatic vessels, leaving the testicle *in situ*, and removed the testes at periods varying from four days to three weeks after operation. The testes were examined histologically. In no instance did gangrene occur. Microscopically, some of the testes, especially the earlier ones, showed some necrosis in the interior of the testis, but around the periphery the alveoli presented a fair state of preservation. Upon second thought, I have come to the belief that I removed the testes too soon after operation, not permitting sufficient time for regeneration. While my experiments are therefore not

[8] Langenbeck's Archiv., vol. xxiv.
[9] Journal of Anatomy and Physiology, vol. xxx, p. 81.
[10] American Journal of Anatomy, 1909, p. 463.

entirely convincing in affording a proof of perfect preservation of the testicular tissue after ligation of the spermatic vessels, they do prove the important point, namely, that the testis does not become gangrenous. When we consider that undescended testes, as shown by Haines, are in all probability non-spermatogenetic, the problem after all, whether the alveoli of the testis are destroyed or not, is a matter of small consideration.

If further proof were wanting, the results of the Bevan operation speak for themselves. In no case of my series did necrosis of the testicle occur, and the preservation of erectile power is, to a certain extent, proven by the maintenance of perfect *potentia cœundi* in one adult case of bilateral undescended testes which I operated.

RESULTS.

I have operated on eighteen patients by the Bevan method. Fourteen were operated at Mount Sinai Hospital, and four at the Har Moriah Hospital. Inasmuch as four were bilateral, I have performed the operation twenty-two times. The first case was operated upon July 26, 1905, the last case in August, 1910. I have kept most of these cases under continuous observation, and I may add that with the exception of my second case, in which the testis is even more atrophic than at the time of the operation, the final result is more than satisfactory. Primary union resulted in every instance; there is no recurrence of the hernia; the testis is freely movable and in the very bottom of the scrotum. In other words, all these patients can be legitimately regarded as completely cured, as far as the descent of the testis and the hernia is concerned. I do not believe that any other operation for undescended testis can establish a record comparable to this.

The purpose of this paper is therefore an advocacy of the Bevan operation. I do this not only from a sense of pleasure over the results that it has afforded me, but also because the operation, if the infrequency with which the operation has found its way into the literature is a criterion, has thus far found few adherents.

RESECTION OF THE MALE RECTUM FOR CANCER, BY THE COMBINED METHOD IN TWO STAGES.*

FIRST STAGE UNDER SPINAL ANÆSTHESIA.

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A MAN, age twenty-seven years, machinist by trade, had mucous discharges from the bowel for six months prior to operation, with passage of blood only two or three times. He had lost about twenty-seven pounds in weight. In the anterior wall of the rectum, was a tumor whose lower limit was between one and a half and two inches above the upper margin of the internal sphincter, while above, it reached to the anterior valve of Houston. It measured transversely from about one and a half to two inches. A microscopic diagnosis of adenocarcinoma was made.

Wishing particularly in the case of this very young man to preserve the normal bowel control which would enable him to continue unhandicapped a life of usefulness, it was concluded to perform, if possible, resection of the rectum. To determine whether or not resection could be accomplished, it was quite essential that the abdomen be first opened, to ascertain, first, whether the tumor was adherent to the base of the bladder, and second, whether the sigmoid flexure above the disease was capable of sufficient descent to re-establish the continuity of the bowel.

Perhaps the greatest objection to attempting resection of the rectum is the prolonged anæsthesia needed for its accomplishment. It was reasoned that if spinal anæsthesia could be utilized for the abdominal portion of the operation, then the rest of the operation through the posterior route could be done under ether at a second sitting on the following day, and the period of ether anæsthesia thus considerably shortened.

* Case presented before the New York Surgical Society, Oct. 12, 1910.

The administration of spinal anæsthesia in a way to secure analgesia of the abdomen has been scientifically worked out by Barker,[1] who employs therefor a particular posture of the patient and as anæsthetic a stovaine-glucose solution having a specific gravity much heavier than that of the spinal fluid. The patient is placed in Barker's position by laying him on his side on a flat table with his hips elevated on a block one inch thick, and his head and neck raised as nearly vertical as possible. This posture throws the spinal column and cord into a position of lateral curvature, the most dependent point of which is about the mid-dorsal region, to which level the specifically heavy stovaine-glucose solution gravitates when injected at the midlumbar region, and exercises there its paralyzing effect on all of the cord below. The head and neck are elevated so as to keep the locality of the foramen magnum beyond the reach of the specifically heavy stovaine solution. The elevation should be maintained for a time following the operation. When the patient is turned on the back the locality of the dependent point in the spinal curve is not materially altered. If the patient remains on his side, analgesia is confined to the side on which he is lying. In manœuvring to secure as much Trendelenburg position as possible for use in this case without too much lowering of the head, it was found that by raising the foot of the table so as to incline the latter about 4 degrees, and then placing the hips on a sand pillow about one and a half inches in thickness, the head and neck being at the same time propped almost upright, the foramen magnum still lay well above the level of the dorsal dip. This posture was therefore employed both for the lateral position during the administration of the injection, and afterward for the dorsal position as well, to which latter, in order to allow the pelvis to tilt forward, there was added the support of the thighs in the flexed position by sand bags and pillows beneath the knees. It was found at operation that this dorsal posture fulfilled all the requirements of the Trendelenburg position. It can be seen that spinal anæsthesia for the second stage of this operation, at least with the use of a specifically heavy anæsthetizing solution, would be contraindicated, on

account of the necessity in it of lowering the patient's head while anastomosing the bowel ends.

The patient was prepared for operation by the administration of castor oil on the preceding third and second nights, followed on the day and night immediately before operation by enemata, which were repeated until the abdominal wall was a little retracted, and the administration of deodorized tincture of opium.

Except for the two-stage feature, the operative procedure in this case of resection of the rectum was quite similar to that in another case already illustrated by the writer.[2]

First Stage, June 24, 1910.—Spinal anæsthesia was administered in the lateral posture, and right afterward the patient was placed in the dorsal posture, as above described. The puncture was made between the second and third lumbar vertebræ, about 10 c.c. of spinal fluid were removed as a preventative against vomiting and headache, and then 0.06 gramme of stovaine * was injected. Complete analgesia up to a level about two inches above the umbilicus was quickly produced and lasted just 50 minutes. The abdominal wall was perfectly relaxed. The analgesia terminated abruptly, and the pain for the remainder of the operative procedure was deadened with a surprisingly small amount of chloroform. The abdominal operation lasted 1¼ hours. It took a few minutes longer to effect the posterior drainage opening. The operative steps were as follows: Median abdominal incision. The prerectal space was first opened up presenting a normal cleavage between rectum and bladder, thus establishing at once operability. The sigmoid flexure was estimated to be capable of sufficient descent to permit of resection, there seeming to be a sufficiently long sigmoid loop with a mesosigmoid of a proper anatomical formation to permit the piece of bowel above the disease, after being freed by division of the mesosigmoid proximal to the arterial arcades, to be brought about six inches below the left common iliac artery. The rectum was then freed behind, the internal iliac and superior hemorrhoidal arteries were isolated and tied, the lateral neurofibrous attachments of the rectum to the pelvic wall (pelvirectal attachments) were isolated and cut, thus mobilizing the remaining

* The anæsthetic solution here used was made according to Barker's early formula, which was stovaine, 10 per cent., and glucose, 5 per cent. Later Barker used a solution containing stovaine, 5 per cent., and glucose, 5 per cent.

paraprocteal attachments so that in the second stage they could be hooked downward with the finger through the posterior wound and severed widely, and both peritoneal leaves of the meso-sigmoid were cut, and two sigmoid arteries isolated and tied proximal to the arterial arcades. The left peritoneal attachment of the sigmoid was cut high in the iliac fossa and the corresponding piece of bowel stripped out of its bed to allow a maximum descent of the freed segment. The posterior lymphatics of the rectum were infiltrated up to the site of entrance into the bowel of the superior hemorrhoidal vessels. The peritoneal opening was narrowed by drawing together its edges at the upper portion of the pelvic cavity with three stitches, behind the liberated bowel. A 20-inch-long rectal tube was inserted into the bowel for the escape of wind. It did not reach quite through the entire length of the freed loop. The tube was rather stiff, and soon after finishing the operation, fearing that it might cause undue pressure on the bowel up in the iliac fossa, it was drawn down about eight inches. The deep abdominal wound was supported by three kangaroo stitches in anticipation of the ether anæsthesia to be administered on the following day. A drainage opening was finally made alongside the coccyx into the retrorectal space.

Immediate Result.—There was not a particle of shock. There was no nausea, headache, or abdominal distention. The patient began to drink water three hours after the completion of the operation, and was able to take it freely. He also took during the afternoon and evening twelve ounces of milk. He passed a comfortable night. The next morning just before operation the rectum was washed with a borax solution which removed considerable mucus, and the tube introduced on the previous day was withdrawn. The patient was given Magendie minims vii and atropin grain 1/50 an hour preceding operation.

Second Stage, June 25, 1910.—Patient anæsthetized in the position for beginning the operation, which was on his left side with thighs and knees semiflexed, starting with chloroform so that there should be as little straining as possible, and then changing to ether. There was in this way no struggling. The sphincters were then stretched, and with a gauze wipe the rectum was determined to be practically dry. An inch wide strip of gauze soaked in a chinosol solution 1 in 500, was introduced into the lower rectum and anus for their disinfection, until

the time for opening the bowel should arrive. The posterior approach devised by myself [3] was utilized. This consists of a central incision which diverges at the coccyx from the median line to pass through one ischiorectal fossa, avoiding the inferior hemorrhoidal nerves, with two wide lateral cuts, the reflection of the coccyx in one of the lateral flaps, and the removal of the portion of the sacrum below the inferior lateral angles. In making the posterior incision there was free bleeding from but three or four small points in the soft parts. There was some hemorrhage in dividing the sacrum, which soon became self-arrested. There seemed to be no median sacral artery. The lateral paraprocteal attachments of the rectum were easily hooked down over the finger and severed. A middle hemorrhoidal artery lay in these structures on the right side, which on division spurted freely, this notwithstanding the preliminary ligature of the internal iliacs. The left middle hemorrhoidal artery was dissected out and tied before severance. The bowel was freed down to the upper level of the internal sphincter. A narrow iodoform strip was now passed up along either side of the bowel into the peritoneal cavity, and one anteriorly, and a temporary gauze pack was made to occupy the wound cavity to protect against infection during division of the bowel. The bowel was clamped across an inch below the tumor just above the internal sphincter, and severed close to the clamp. The severance was made according to the technic of Kraske, by interrupted cuttings and the placing of traction loops of heavy silk at intervals along the margin of the distal segment as it became freed, for the subsequent control of the edge in suturing. The patient was now put in Kraske's dorsal position, with high elevation of the hips and thighs flexed over the abdomen, for suture of the bowel ends. The bowel was sectioned above the tumor opposite the site of entrance of the superior hemorrhoidal vessels, which was just beyond the indurated posterior lymphatics. A higher division of the bowel would not have left enough to re-establish the continuity of the gut. In dividing across the mesenteric border of the descended gut, there was a marginal artery which spurted freely. The portions of the peritoneal leaves of the mesosigmoid which remained attached to the freed proximal end of bowel, causing the latter to curl a little on itself, were cut where they exercised restraint to the straightening out of the gut.

The bowel ends were sutured together for most of the circuit, with interrupted sutures of stout iron-dyed twisted silk tied on the inside, and a few chromic sutures placed externally effected the final closure. Celloidin linen thread for the inner stitches would probably be preferable to silk. A stout full-curved round needle was used. Care was taken to include serous surfaces of the proximal segment within the grasp of each stitch. The mesenteric attachment of the proximal segment lay in the posterior median line of the anastomosis, at which site serous surfaces were brought into the line of union by a Maunsell mesenteric stitch. For the avoidance of stricture, care was taken to make an even coaptation of the mucous edges, the latter being first caught with sutures (which included the edge of the serous coat of the proximal segment) at intervals at opposite points, and then by traction on any two of these adjoining stitches the mucous edges would be held evenly in apposition while deeply placed stitches, including about half an inch of either margin, were passed and tied. When the anastomosis was completed, the temporary gauze packing was removed, and a gauze strip soaked in glycerin was placed gently upward along either side of the bowel and in front of the lower portion of the sacrum. There was no drain placed near the suture line. In fact the levatores ani were drawn together directly over the posterior portion of the suture line in the hope of getting an early adhesion here with serous surface that would fortify the union. The lateral muscular cuts were each approximated with two or three chromic sutures. A small double-barrelled tube drain was inserted through the anus.

Result.—Recovery uneventful except for the development of a small fistula on the eighth day, which was one day before the bowels were moved. Highest temperature 101° on the seventh day. Tincture opii deodorat. administered. The patient did not suffer from abdominal distention. He expelled wind freely through the tube in the anus. On the fourth day the glycerin gauze drains were removed, on the sixth day the two lateral iodoform strips were taken out, and on the seventh day the anterior one. The interior of the bowel was syringed every day with a chinosol solution, 1 in 500, and on the fifth day the daily injection of a little olive oil was begun as well. The reflux from these syringings was practically always clear. When

the bowels were moved on the ninth day, all the discharge, which was watery, came through the posterior wound. At the same time the effort to discover the fistulous track into the bowel with a probe was unsuccessful for some days. The opening, which was not large, was located anterolaterally on the right side. The patient had lain chiefly on his left side, toward which the bowel evidently sagged, thus removing the suture line on the right side from a perfect apposition with the surrounding tissues and consequently interfering with the opportunity for a supporting adhesion to form at this portion of the periphery. The leakage may, however, have been due to infection. The lateral cuts healed by primary union, as did also the abdominal wound.

The wound has gradually closed. Since the middle of September there has been no fecal leakage, and during the past ten days (prior to October 12) escape of wind through the fistula has been noticed but twice. (On November 7, the fistula had completely healed.) The sphincters functionate normally, and there is no stricture at the seat of anastomosis. The patient has regained his normal weight. (On November 7, he had gained 36 pounds.)

Dr. Crowell who examined the specimen, reported that the tumor had apparently been excised beyond the limits of the disease. Sections at three levels at the upper part of the indurated posterior lymphatics showed evidence only of an inflammatory process.

Special Considerations.—1. The abdominal portion of the combined operation in resection of the rectum may be done under spinal anæsthesia without any shock.

2. *Lumbar puncture* can be made a very simple procedure if the needle be introduced in a direction forward and very slightly inward just lateral to the interspinous ligament. The skin should be nicked about one-third of an inch from the median line at the site of introduction of the needle. The first deep guide is the ligamentum subflava which offers its resistance to the needle point, and next is the dura beneath it, puncture of which with a needle not too sharply pointed, can usually be felt, or may even be heard. The writer has employed this technic on occasion, always satisfactorily, for

several years, but wishes to acknowledge that a similar technic has recently been published by H. Tyrrell Gray [4] who, using the same deep guides, directs the point of the needle inward and a little upward toward the posterior median line of the dura. By this method one can be readily guided by the sense of touch, which latter, in a median puncture where the needle must traverse the dense supraspinous and interspinous ligaments, would at least have little delicacy. Gray reports that in 200 cases of lumbar puncture by the method described, he touched a nerve twice with no other ill result than momentary pain, and once in a case of fracture of the base of the skull, with resulting cessation of respiration for a considerable period of time, apparently excited by a definite movement of the needle. The writer uses a platinum needle with an extremity cut diagonally at such an angle as to make a short oval opening and a point that is not too sharp.

3. Barker brings out the fact that stovaine solutions may be boiled at 115° C. for 15 minutes without loss of potency. Another factor in the use of stovaine is, that sodium carbonate or other alkaline fluid neutralizes its action, so the injecting syringe and needle should be boiled in plain water.

4. Since in this case only just enough bowel could be liberated by the abdominal route to reunite the ends after excision of the disease, cutting the attachments upward into the iliac fossa, a resection of the bowel with end-to-end suture could not have been accomplished by the posterior route alone, much less an implantation within the denuded sphincters.

5. Since the preliminary *ligature of the internal iliac arteries* did not control the hemorrhage from the middle hemorrhoidal branches, its chief advantage in the male must be for limiting the hemorrhage in the making of a posterior or perineal approach. *Technic:* The internal iliac arteries can be very easily isolated for ligature by passing the finger beneath the fascia propria recti, locating the bifurcation of the common iliac, which is situated about one inch lateral to the promontory, and stripping with the finger, using some force, from the angle of divergence of the two vascular trunks,

downward and backward along the anterior border of the internal branch. The fascia teases through and the artery raises off from its accompanying vein. This procedure, done by the sense of touch, facilitates very greatly ligature of these vessels. It was practised in this case. For stripping the artery free, it is better to stand on the side of the patient corresponding to the vessel, but in passing the ligature, it is better to stand on the side opposite to the vessel.

6. The surgical importance of the *lateral pelvirectal attachments* [5] may well be again emphasized. The severance of these unyielding, fascial, nerve-supporting connections between rectum and pelvic wall, extending from just below the level of the ureter to the fourth sacral foramen, is very important in the mobilization of the rectum.

7. The posterior approach here employed gives a broad operative field for performing the anastomosis, affords good drainage, and is easily closed around the drainage opening. It has healed promptly in two cases where it has been used, re-establishing firm support.

8. When, in resecting the rectum by the combined operation, the bowel is divided through the posterior wound after having packed off the peritoneal cavity, and a tight anastomosis made with a complete circular suture, the danger of fecal infection of the peritoneal cavity must be *nil*.

9. If the mucous edges of the bowel ends be evenly coapted, provided union take place, there should be no stricture.

REFERENCES.

[1] Barker: British Medical Journal, 1907, i, p. 665; and *Ibid.*, 1908, i, p. 244.
[2] Lusk: Surgery, Gynæcology and Obstetrics, ix, 1909, p. 491.
[3] Lusk: *Ibid.* and Surgery, Gynæcology, and Obstetrics, vii, 1908, pp. 205–207, 222.
[4] Gray: Lancet, 1909, ii, pp. 913, 991.
[5] Lusk: Surgery, Gynæcology, and Obstetrics, ix, 1909, p. 501.

FRACTURE OF THE TARSAL SCAPHOID.

WITH A REPORT OF CASES TREATED BY OPERATION.

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THE treatment of two cases of fracture of the tarsal scaphoid, in the Orthopædic Department of the Carney Hospital within three months of each other, makes timely this report and a review of the literature of previously reported cases. Practically no mention is made in our latest text-books on fractures of the tarsal scaphoid other than that made by Stimson to the effect that its occurrence is rare, except with other tarsal fractures.

Fracture of the scaphoid is due usually to violence from falls, received either in forced dorsal or plantar flexion. In striking so, the scaphoid transmits the whole force of the violence.

Slight twists occasionally accompanied by a Pott's fracture can result in a fracture of the scaphoid. The local sign is the swelling from disturbance of circulation and trauma, exaggerated when a dislocation of the fragment has taken place. Tenderness over the scaphoid on the inner side depends largely upon the time elapsing after the fracture.

Ankle-joint motions in flexion and extension are normal, but when forced are accompanied by pain referred to the scaphoid. The midtarsal motions are markedly restricted. The foot is held in slight eversion, and practically no inversion is possible. Both the lateral and anteroposterior radio-

grams will show the fracture and displacement. The treatment in these cases is conservative for at least the first few days. If the displaced fragment can be reduced and the foot held in inversion, we may expect a good functional result. If, however, this is impossible, operative treatment should be at once begun. This fracture, located as it is, and so important to the normal arch of the foot, will not permit of any laxity of treatment. The whole static mechanism of the limb is involved and is readily thrown out of plumb by an improperly reduced fragment or malunion. We believe that operative interference resorted to early, not only is safe, but insures better function and less static disturbance.

Operative Treatment.—This consists of (*a*) cutting down upon the fractured scaphoid and taking out the fractured portion; or (*b*) making an excision of the scaphoid *in toto,* leaving as much of the periosteum as possible in order that regeneration of bone may take place. This latter procedure is especially satisfactory, as the remaining scaphoid is usually crushed and will develop hyperplastic tissue. The new bone formed will more perfectly fit the space left when proper inversion of the foot is obtained. Following this, the foot should be inverted and placed in plaster of Paris for three or four weeks, after which the plaster should be removed and the foot held by spiral strapping. Later a light spring plate is useful to relieve the operated region from strain in weight-bearing. After six or eight weeks, baking and massage will help to increase the circulation and restore the tonicity of the foot. Passive motions should then be encouraged, and the patient given crutches. A good functional result was obtained in the two cases reported below.

Hoffman calls attention to the rarity of these fractures, and finds only twenty-two reported in the literature. He states that diagnosis can only be positively made by the use of the radiograph. He recommends plaster dressing in acute cases and operative interference in obstinate and deformed cases, thereby leaving the periosteum to develop new bone. In the severe cases, with arthritic changes, he excised the whole scaphoid.

FIG. 1.

R. M. Fracture of tarsal scaphoid with dislocation of fragment. Taken before operation.

FIG. 2.

W. F. Note prominence over scaphoid and swelling.

FIG. 3.

W. F. Lateral view—swelling obliterating posterior arch.

FIG. 4.

W. F. Fracture of tarsal scaphoid with dislocation of fragment. Taken before operation.

FIG. 5.

W. F. Anteroposterior view of Case II. Taken before operation.

Main

Deutchlander states that conservative treatment is useless. This experience is corroborated by Bahr, who has excised one scaphoid *in toto,* and the displaced fragment in one other. Deutchlander's results in two cases have been good.

CASE I.—R. M., age sixteen. Patient entered the Orthopædic Department of the Carney Hospital March 2, 1909, and gave the following history:

Family History.—Negative.

Present Illness.—Six months ago fell from a door-step and at that time seemingly injured the right ankle only. Left ankle was lame but did not cause any great amount of inconvenience. Two months after, patient turned left ankle and has had pain in the region of the inner side of scaphoid ever since. Condition has gradually grown worse.

Physical Examination.— Left foot held slightly in a position of eversion and a prominence noted on the inner side of scaphoid. Ankle-joint motions were good. Inversion and eversion at the midtarsal joint, especially the former, limited. Tenderness over prominence corresponding to inner head of scaphoid. X-ray taken (see radiogram, Fig. 1). Diagnosis: fracture of tarsal scaphoid. Referred to House.

March 3, 1909: Ether; operation. An incision about three inches long was made parallel to the dorsum of the foot (*lt*), and over the inner side of the scaphoid. Fascia and periosteum were divided and separated from the scaphoid. The scaphoid bone was soft and there apparently was no attempt made at repair. Owing to inability to correct the foot in inversion the scaphoid *in toto* was excised.

A correct position was possible following this procedure. Chromic catgut was used to sew fascia and periosteum together, while the assistant so held the foot in inversion as to practically obliterate the cavity previously occupied by the scaphoid. The skin was closed with catgut and the foot placed in a light plaster cast in marked inversion. Good ether recovery and uneventful convalescence. March 8, 1909, discharged from House.

Subsequent treatment was removal of cast in four weeks, followed by spiral strapping and a light spring plate to support the longitudinal arch until the musculature was redeveloped. When patient was last seen functional result was excellent. Since then, has been lost sight of.

CASE II.—W. F., thirty-nine years, single.

Family History.—Negative.

Personal History.—Negative.

Present Illness.—Five months ago fell 22 feet from a scaffold, landing mostly on left foot. Has had pain in ankle and used crutches to walk since the accident. Had strapping and bandaging without relief.

Physical Examination.—Left ankle prominent and enlarged over scaphoid. Ankle-joint motions limited only in extremes. Midtarsal joint motions markedly restricted and accompanied by pain referred to region of scaphoid. Considerable muscle spasm and rigidity. Foot in position of valgus, which cannot be corrected. Considerable thickening around the scaphoid. Photographs taken (see photographs, Figs. 2 and 3); radiogram taken (see radiograms, Figs. 4 and 5). Diagnosis: fracture of tarsal scaphoid. Referred to House.

June 9, 1909: Ether; operation. A semicircular incision made and the same technic followed as in the above case. Only the fractured portion of the scaphoid bone was removed. No attempt at union could be seen. Wound was closed in usual manner, and foot put up in an inverted position. Uneventful convalescence. Removal of plaster cast in four weeks. Strapping and plate used. Baking and massage were useful in attaining better circulation and function. Result: a good functional foot.

CONCLUSION.—Fracture of the tarsal scaphoid, although rare, may occur without fracture of other tarsal bones. In both cases swelling and tenderness existed over the scaphoid. Ankle-joint motions were normal, but a marked limitation in inversion was present and in abduction at the mediotarsal joint. Correction could not be attained by manipulation.

The scaphoid in structure was found in both cases to be a good deal like the softening occurring in old ununited intracapsular fractures of the head of the femur.

Excision of the scaphoid seems justifiable and remarkable, in that the static condition of the foot is not weakened but markedly improved in the two reported cases by this procedure. In new cases where the injury has just occurred,

the deformity occurring would suggest the foot being put in plaster in a marked varus position.

Lange, of Cincinnati, covers some of the methods of recognizing such fractures, and believes them to be more numerous since the use of radiography.

Nippold calls attention to errors in diagnosis on account of accessory sesamoids.

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CHARLES ROBERT BELL KEETLEY, F.R.C.S.

MR. CHARLES R. B. KEETLEY died at Brighton, England, on December 4, 1909, of heart failure, in the sixty-second year of his age. It is especially proper that the ANNALS OF SURGERY should record an appreciation of the character and work of Mr. Keetley, who was one of the founders of the Journal, and who during the earlier years of its history was a very frequent contributor to its pages, and who during his whole subsequent life remained its warmly interested friend. The first paper in the first issue of the ANNALS OF SURGERY was from the pen of Mr. Keetley. The title was "On Removal by Scraping out of the Marrow of Long Bones, and Especially on this Proceeding as a Treatment of Osteomyelitis." This paper displayed in a marked manner the peculiar characteristics of Mr. Keetley's mind,—his avidity for new truths, his readiness to accept and act upon the experience of others, and his own ingenuity and resourcefulness in the working out of new ideas. In this article Mr. Keetley struck the keynote which has characterized the ANNALS OF SURGERY throughout its entire history. Of the very elaborate Review of the Surgical Year which was published as an editorial article in the same number of the ANNALS OF SURGERY, Mr. Keetley contributed that portion of it devoted to British surgery. Mr. Keetley took a warm interest in the organization of that department of the Journal known as the "Index of Surgical Progress," and succeeded in enlisting the co-operation of a large number of his colleagues in this department, so that among the list of contributors to that first volume appear the names of Ball and Thomas of Dublin, Cathcart of Edinburgh, Chavasse and May of Birmingham, Wherry of Cambridge, Street of Westgate, and Clark, Dunn, Edwards, Eve, Fenwick, Gould, Hutchinson, McNamara, Pye, Schacht, and Weiss of London. At the special invitation of the writer Mr. Keetley contributed to the special number which concluded the fiftieth volume of the ANNALS OF SURGERY the article which concluded the issue, so that of the first fifty volumes of this Journal the first and the last of the original

memoirs which appeared in its pages were contributed by this one surgeon. The final contribution of Mr. Keetley did not appear until after the death of its lamented author.

The first acquaintance of the writer with Mr. Keetley was made in 1878 in the out-patient department of St. Bartholomew's Hospital. The acquaintance then made soon ripened into a friendship which lasted during more than thirty years, until his death. It was during an after-dinner talk in London, in the spring of 1884, that the idea of a surgical journal which should comprehensively represent both British and American surgical work was discussed between us, and, as I have already mentioned, in an historical note previously published, when upon my return to New York shortly thereafter, Mr. Chambers of St. Louis approached me with a proposition for the editing of such a journal, I at once turned to Mr. Keetley for collaboration. This he gave heartily and without stint, and it has always been a great pleasure to acknowledge the indebtedness which is due from the ANNALS OF SURGERY to him for the assistance which he gave in its foundation.

Mr. Keetley was born on September 13, 1848, at Grimsby, being the son of Mr. Robert Keetley, a ship-builder of that place. He began his professional education in the Hull Infirmary, and later entered as a student at Saint Bartholomew's Hospital. As a student he received gold medals at the London University in anatomy and materia medica. After qualifying in 1873 he became house surgeon at the Queens Hospital, Birmingham. In 1876 he took the fellowship of the Royal College of Surgeons of England, and having settled in London was for some years thereafter an assistant demonstrator of anatomy at Saint Bartholomew's Hospital. In 1879 he was appointed assistant surgeon for the West London Hospital, and Mr. Stephen Paget in the course of an obituary notice published in the *Lancet* says of him:

"The true beginning of his surgical career came when he was appointed assistant surgeon to the West London Hospital. It is not too much to say that no hospital ever had a more zealous and faithful servant. From the day he first entered there to the time of his last illness he gave his mind and his strength, even with a sort of extravagance, to its advancement

and welfare. During his thirty years of service the West London Hospital grew from a suburban venture to a great general hospital for a million people, to which is affiliated a great post-graduate school. Keetley's name will ever be associated with this development of the place that he loved. There is little doubt that he could have lived longer if he could have been persuaded to allow himself more rest. He was far more careful of other people's wants than of his own, and his high place in our profession would have stood even higher if he had been more businesslike in his private practice."

In the same article Mr. Paget compares Mr. Keetley with John Hunter in these words:

"Both men alike were thoroughly methodical in the actual practice of surgery at the bedside or in the operative theatre, but were inclined to be neglectful of their own advantage and well-earned payment for their work. They were men of the self-same temperament, of singular tenacity of purpose and force of will, able to go forward over all kinds of obstacles, and in the end to be successful. Each of them also was emotional, readily moved either to anger or pity or to generosity."

In the course of an appreciative note to the *British Medical Journal,* Mr. Swinford Edwards, a personal friend and colleague of Mr. Keetley for thirty years, says:

"I should say that Keetley's chief characteristics were his honesty, single mindedness, and generosity. He was a man of great energy, dogged determination, and much resourcefulness in operations. Initiative was another of his strong points, as witness the founding by him of the West London Medical and Chirurgical Society, which is one of the largest and best attended societies in London; the Ladies' Association in connection with the hospital; and the Lincolnshire Society, which I believe largely owes its being to his exertions. The same may also be said of the West London Post-Graduate College, which has proved such a success. He was a recognized authority on orthopædics, and the results of many of his cases of plastic surgery were brilliant. His recent works on appendicostomy and on the preservation of the appendix have attracted much notice. We of the West London shall miss him as a real friend, to whom we could turn for help in

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C. B. Keeler

any difficulty, and we shall always remember him in his lighter moments for his very humorous and witty afterdinner speeches, and for his great talent as a pen and ink caricaturist. He was a Fellow of the Medical Society of London and of the Royal Society of Medicine, a corresponding member of the American Orthopædic Society, a member of the Harveian Society, and vice-president of the Balneological and Climatologic Society. He was the author of "An Index of Surgery," which was widely read by students preparing for examination as well as by practitioners, and of which the fourth edition appeared in 1887. He wrote also "The Students' Guide to the Medical Profession," second edition 1885, "Orthopædic Surgery," 1900, and "Complicated Fractures," 1902. He contributed many valuable papers to the medical journals, chiefly upon orthopædic, abdominal, and plastic surgery. He initiated the Army Medical Civilian Reserve, the first unit of which went through a course at the West London Post-Graduate College. His scheme was subsequently merged in the territorial force; Keetley, together with Dr. Fowler, Mr. Godlee, and Sir Thomas Barlow, was appointed a lieutenant-colonel, available on mobilization, in the Third London General Hospital territorial force."

Mr. Rickard Lloyd, in a contribution to the *Lancet,* says:

"Keetley always engaged in his work from a love of the science and a determination to practice it as skilfully and successfully as surgical records showed possible, and to improve upon these records if he could. The courage, thoroughness, ingenuity, and resource which he always displayed were especially shown in the 80's and 90's, when operations were increasing in magnitude and variety almost every day. He was one of the first to adopt Listerian methods, and in his operations he always from the beginning of his hospital career insisted upon thoroughness in antiseptic preparations and precautions. Although so bold a surgeon, he was a very careful one. He allowed as little blood as possible to be lost, and he liked his patients to have the minimum of the anæsthetic administered, preferring ether to chloroform. The results of his operative work were extraordinarily good.

"Keetley's social talents were great, despite his infirmity

of deafness. He was exceedingly interesting, original, and generally amusing in his speeches, and a very clever artist. I have seen him illustrate his surgical work scores of times with clever drawings, which he made with amazing rapidity and exactness. I have seen many humorous and caricature drawings that he has made when out of the range of some speaker—and unfortunately deafness, his great misfortune in life, often placed him there."

Mr. Keetley was of good physique and splendid muscular development. The accompanying portrait shows well his personal characteristics. The firm mouth and chin, the finely cut and large nose, and the twinkling eyes suggest the mingling of energy and tenacity and humor which were his essential characteristics. During his student days he was a keen athlete, and was well known as a good foot-ball player, oarsman, and boxer. It is more than probable that at this period he injured his heart, for the existence of the cardiac defect to which he ultimately succumbed was known to him for many years, although his most intimate friends were unaware of it. The last occasion on which the writer had the privilege of seeing Mr. Keetley was in October, 1908. At this time there was no indication that there was any abating of his natural force. An afternoon spent with him at the West London Hospital was full of interest, and the probabilities of a continuance of his surgical activity and great professional usefulness for many years were marked. His response the following year to a request to contribute to the Fest-number, closing the fiftieth volume of the ANNALS OF SURGERY, was cordial and immediate. The news of his sudden death was therefore unexpected, and brought to the writer profound grief.

To Charles B. Keetley,— as a surgeon, skilful, progressive, and bold; as a man wide in his interests, generous, self-sacrificing, and tenacious; as an administrator, broad-minded, sagacious, and planning for the future as well as the present; as a scientist, restless, earnest, and open-minded,—the friend of many years, and a sympathetic and laborious colleague in many labors, the writer now pays this final tribute of affection and respect.

LEWIS S. PILCHER.

TRANSACTIONS
OF THE
NEW YORK SURGICAL SOCIETY.

Stated Meeting, October 12, 1910.

The President, Dr. Ellsworth Eliot, Jr., in the Chair.

RESECTION OF RECTUM BY COMBINED METHOD IN TWO STAGES: FIRST STAGE UNDER SPINAL ANÆSTHESIA.

Dr. William C. Lusk read a paper with this title, for which see page 836.

Dr. Howard Lilienthal, after examining the case shown by Dr. Lusk, said the line of union between the mucous edges of the gut was absolutely perfect, and both the patient and Dr. Lusk were to be congratulated upon the result. The case was an excellent example of what could be accomplished in these very difficult cases. It must be recognized, Dr. Lilienthal said, that carcinoma in this region, especially adenocarcinoma, is comparatively non-malignant, so that the patient's chances of recovery were good. The speaker recalled one case of adenocarcinoma of the large intestine at the hepatic flexure which he operated on twelve years ago, and eleven years elapsed before the patient returned with a carcinoma of the rectum, which was of an entirely different type than the original growth. This was also removed, but the patient had since died.

Dr. Lilienthal said he approved of the two-stage operation in cases like the one shown by Dr. Lusk, and he believed that it contributed largely to the patient's recovery.

TOTAL LARYNGECTOMY FOR EPITHELIOMA: LOCAL ANÆSTHESIA.

Dr. Alfred S. Taylor presented a man, 49 years old, who came to the Fordham Hospital in May, 1910, with the diagnosis of epithelioma of the larynx. The growth had developed to such a size that he was unable to breathe excepting in the upright

position, and he also had some difficulty in swallowing. He had lost much weight, and was exceedingly thin and cyanotic.

On account of the location and extent of the growth and the patient's generally unfavorable condition, a general anæsthetic was deemed inadvisable, and it was determined to do a laryngectomy in two stages, first separating the trachea from the larynx, and then, after a week's interval, completing the extirpation of the larynx.

The first stage of the operation was done on May 20, 1910, the following local method of anæsthetizing the parts being employed: With a needle, a 4 per cent. solution of cocaine was injected into the sensory branches of the cervical plexus on both sides of the neck at the middle of the posterior border of the sternomastoid muscles. Dr. Taylor said that prior to attempting this, he had made a large number of dissections on the cadaver, which had convinced him that by injection he could get the cocaine into those nerves either directly or by diffusion. This proved to be the case, as the local anæsthesia was entirely satisfactory.

A sufficiently large incision was then made upward from the episternal notch, through which the upper end of the trachea was dissected out and divided transversely and sutured to the skin with heavy silk sutures. As soon as the trachea was separated from the larynx, a considerable quantity of thick mucus was coughed up, which relieved the patient a good deal.

A week later, under cocaine anæsthesia injected into the sensory branches of the cervical plexus as before, the laryngectomy was completed. The anæsthesia during this operation, as during the primary operation, was very satisfactory, and there was practically no pain excepting when working in the neighborhood of the laryngeal nerves. In addition to the larynx itself, a considerable amount of the mucous membrane posterior to the larynx was removed in order to go wide of the disease. A tube was then inserted through the nostril, and the mucous membranes sutured around it with chromic catgut. The patient got along well for five or six days; then these sutures through the mucous membrane gave way, resulting in a fistulous tract, and the foot of the bed had to be elevated to save the patient from drowning in his own secretions.

In order to catch the very free secretion from the wound, a

small pouch was formed over the opening of the trachea by a plastic operation, and through this the patient was able to feed himself through a tube which he passed down into the œsophagus. Just before he left the hospital, he was able to swallow water for the first time with very slight leakage through the fistula. When he returned, about two weeks later, it was found that a stenosis had formed at the pharyngeal scar, so that he was unable to swallow or even introduce the tube into the œsophagus. On August 20, 1910, the patient was etherized through the tracheal tube, and the old scar was dissected out. The upper end of the œsophagus was then separated from the lower end of the pharynx and sutured to the skin, so as to give a free opening for the use of the stomach tube. Since that time the patient had been comfortable and was able to feed himself with the aid of a stomach tube, which he introduced through the opening in the neck.

Dr. John F. Erdmann said the method of anæsthesia employed in the case shown by Dr. Taylor was most interesting and absolutely new to him. The opening made in the œsophagus was also a novel method of procedure. In his own series of cases of complete laryngectomy, numbering perhaps six or seven, a stenosis of the œsophagus and pharynx developed in one instance, necessitating a gastrostomy.

Dr. Ellsworth Eliot said that in some of these cases there was a possibility of carcinomatous deposits in the lower part of the œsophagus, and under those conditions a gastrostomy was preferable to an opening higher up. In one case that came under his observation, an œsophagotomy was done, but on attempting to pass a catheter, an impermeable stricture was found lower down; this proved to be carcinomatous, and a gastrostomy had to be done.

Dr. A. V. Moschcowitz said he had done a number of cases of total extirpation of the larynx under local anæsthesia, although not by the method described by Dr. Taylor. He thought local anæsthesia was preferable to a general anæsthetic on account of the danger of post-operative pneumonia. In one of his cases, the operation lasted over three hours, and another almost three hours; but in spite of this long duration, the patients are better off than after a short operation with general anæsthesia.

Dr. Howard Lilienthal said that in any case of extirpation

that he might be called upon to do in the future, he would be inclined to try the intratracheal method of anæsthesia through the tracheal wound. This possessed the advantage of rendering the patient unconscious, and it also avoided the danger of pneumonia, at least to a much greater extent than by the ordinary inhalation method, as by the intratracheal method any secretions would be blown out. Unless it could be demonstrated that the œsophagus was permeable, Dr. Lilienthal said he would regard a gastrostomy safer than an opening higher up.

DR. TAYLOR, in closing, said that in his case there was no obstruction of the lower œsophagus whatever, and the tube could be passed without any trouble.

Dr. Taylor said that by injecting the cocaine into the sensory branches of the cervical plexus as he had described, the entire anterior aspect of the neck was anæsthetized. These nerves supply the sensory branches to this region. One decided advantage of this method over the local injection of cocaine was that it did not give rise to an œdematous condition of the tissues upon which it was necessary to operate. Very little cocaine was necessary, and the anæsthesia it gave rise to was entirely satisfactory. The method was described about a year ago by one of the men connected with the Johns Hopkins Hospital.

RUPTURE OF THE LIVER FOLLOWED BY SUBPHRENIC ABSCESS.

DR. BURTON J. LEE presented a boy of thirteen from the service of Dr. John Rogers at Bellevue Hospital, who gave the following history: About half-past two in the afternoon, while watching a ball game, he was struck on the right side of the thorax, low down, by a bat, which had slipped from the batter's hands as he was attempting to hit the ball. The distance between the latter and the lad was about ten feet. The patient suffered severe and sudden pain in the region named, was almost breathless for an instant, and then felt somewhat better, though he remained weak and soon complained of thirst. He walked about three blocks to the hospital.

When the patient was examined by Dr. Stilson, the house surgeon, about an hour and a half after the accident, he showed considerable shock, and was very pale, weak, and thirsty. There were slight rigidity and some tenderness in the upper right

quadrant of the abdomen, but no dulness in either flank, the latter symptom appearing about two hours later. At that time, the rigidity over the upper part of the right rectus was more marked, and tenderness in the same region had increased. A blood examination made about this time showed hæmoglobin, 100 per cent.; red blood cells, 4,896,000; white cells, 30,000, and polymorphonuclears 89 per cent.

An operation was decided upon, and on opening the abdomen through a vertical incision over the upper part of the right rectus, there was a gush of blood, which was controlled by pressing the liver directly against the diaphragm. The superior surface of the liver was then examined, and a Y-shaped rupture about three inches long was found close to the attachment to the diaphragm, the left arm of the Y extending almost to the median line.

As it was impossible to reach the tear in the liver by either cautery or suture, the hemorrhage was controlled by tightly packing gauze into the rent. A large piece of packing was placed below the liver, with the object of forcing that organ up against the diaphragm. The wound was closed in layers, and a large piece of gauze was tightly strapped against the liver over the wound to further push the liver upward.

Two days after the operation the boy's hæmoglobin registered 75 per cent., with 3,432,000 red cells. On the tenth day the blood analysis gave practically the same results, with 16,000 white cells and 80 per cent. of polymorphonuclears. Transfusion by the Elsberg canula was attempted two days after the operation, but was unsuccessful.

Nine days after the operation the gauze drains in the tear in the liver were completely removed, and no oozing followed. Subsequent to this, there was persistent tenderness over the upper abdomen, with accompanying temperature elevation. Two weeks after the original operation, an exploratory operation was done by Dr. Erdmann over the upper left abdomen, but the findings were negative. A week later the right chest gave signs of dulness posteriorly, low down. Three explorations with the needle were made, with negative results. Six weeks after the operation the right chest was opened by Dr. Lee with negative findings. Two days later, Dr. John A. Hartwell, the attending surgeon, obtained pus by needle exploration on the left side below the diaphragm, and later a large cavity was opened and drained.

This cavity, apparently, did not communicate with the right side of the abdomen. From this time the boy went on to complete recovery. He ran a temperature continuously for seven weeks following the original injury. Five weeks after the first operation, his hæmoglobin had dropped to 20 per cent. His abdominal wound on the left side had now entirely healed, and that on the right side over the original site was but a minute sinus about half an inch long. His general condition was excellent.

The interesting features of this case, Dr. Lee said, were: 1. The site of the rupture in the liver, making the use of suture or cautery impossible. 2. The efficiency of packing in controlling hemorrhage from the liver. 3. The long and complicated course of the case, with the final disclosure of the left-sided subphrenic abscess.

THE ANATOMY AND TREATMENT OF UNDESCENDED TESTIS; WITH ESPECIAL REFERENCE TO THE BEVAN OPERATION.

Dr. A. V. Moschcowitz read a paper with the above title, for which see page 821.

In connection with his paper, Dr. Moschcowitz presented a number of patients showing the result of the method of operation described by him.

Dr. Robert T. Morris thought that in the treatment of undescended testis we had little need for any other operation than that devised by Bevan. A few days after the original description of that operation was published, he employed the method on a case and had found that he could lengthen the vas from two to three inches, and since then he had not found it necessary to resort to any other method. By cutting everything excepting the vas and its artery, the vas immediately unravels for three or four inches without any trouble, as a rule, in adults.

Dr. Morris said he was not altogether sure that it was even necessary to spare the artery of the vas, which followed usually very close to the vas and was quite as tortuous as the vas itself, but he recalled two or three cases where there was an anomalous distribution of the artery and where he was not at all sure that the artery was saved, and yet those cases resulted favorably, the lymphatic circulation apparently maintaining the organ until a new blood supply was established.

Dr. Morris said that should the testicle slough, or in cases where the undescended testis was so small that it was scarcely worth while to bring it down, he would remind the members of the Society of Dr. Robert F. Weir's suggestion regarding the psychical and æsthetic value of a celluloid substitute. The speaker said he had resorted to this procedure in a number of instances, chiefly after the removal of the testis for tuberculosis or as the result of injury. The celluloid substitute for the testis should be immersed in a physiological salt solution just before insertion and after sterilizing it in a 5 per cent. formalin solution. These celluloid substitutes are made to order by the celluloid company in New York after Dr. Weir's models.

Dr. Howard Lilienthal suggested that perhaps the sterilization of the celluloid testis might be dispensed with, as it was already sterile.

Dr. John B. Walker said that in 125 cases of undescended testis upon which he had operated, he did not think that he had employed the Bevan method more than two or three times. He had not found it necessary to divide the vessels. The chief difficulty he had encountered was in the division of the connective tissue.

Dr. Walker said he agreed with Dr. Moschcowitz that the vas was always sufficiently long. He had found that in very young children, when the testis was brought down, the cord gradually lengthened as time went on. In separating the sac from the vas, it was essential to use the greatest care to avoid injuring the parts. As the majority of these operations was done on comparatively young children, generally during the third or fourth year, when the vas was very small, he thought it important that all the vessels should not be divided.

Dr. Howard Lilienthal said he had operated on a number of cases by the Bevan method, and for the most part successfully, but in one instance he was compelled to remove the testis on account of sloughing. That patient was a boy about eight years old, and the operation was very easily performed; the testicle was held in its new position without undue tension, and yet necrosis set in.

Dr. William A. Downes said he had done the Bevan operation as described by Dr. Moschcowitz about twenty times with entire success. In all of his cases it was easy to divide the sac

at the internal ring, and there was no difficulty in saving a sufficient amount of the lower end of sac to form a tunica vaginalis—a step which Dr. Bevan considers very important. Dr. Downes understood from Dr. Bevan that while the dividing of the spermatic artery and veins might be necessary in an exceptional case, that it was not the essential feature of his operation.

Dr. Downes said he had never seen sloughing of the testis in any of his cases. The scrotum usually became ecchymotic, but the swelling disappeared in a few days, and within a few weeks the testis appeared to be in a normal condition. As to the age at which the operation should preferably be done, the speaker said he preferred to operate between the ages of eight and fourteen years rather than earlier.

DR. MOSCHCOWITZ, in closing, said he would not care to operate on these cases earlier than the age of three years; he had operated on children as young as that, and many of the people who brought their children to the hospital were anxious to have the operation done as early as possible. The age at which the operation should preferably be done depended somewhat on the class of patients we had to deal with.

The speaker said that this condition of undescended testis was always complicated by hernia, which could not be taken care of efficiently by any form of truss. In view of the fact that we did not oppose a radical operation for the cure of hernia in a child of three years, he saw no reason why the other condition should not be corrected at the same age. From that time on the operation could be done up to almost any age.

Dr. Moschcowitz said that Dr. Bevan's original article was published in the *Journal of the American Medical Association*, and his more extensive paper in Langenbeck's Archives. He had studied the paper very carefully, and thought he understood its purport, as well as its advantages over the Schüller and other operations; if Dr. Bevan did not claim the points he had mentioned as the particular advantages of his method, then he was sorry for it, because he regarded them as of paramount importance.

BOOK REVIEWS.

EPOCH-MAKING CONTRIBUTIONS TO MEDICINE AND SURGERY AND THE ALLIED SCIENCES. Collected by C. N. B. CAMAC, A.B., M.D. With portraits. Philadelphia, W. B. Saunders Company, 1909.

The title-page of this book states that it contains reprints of those communications which conveyed epoch-making observations to the scientific world, together with biographical sketches of the observers. Upon opening its pages we find that under this head the author has included Joseph Lister and his paper on "The Antiseptic Principle of the Practice of Surgery," read at the meeting of the British Medical Association, August 9, 1867; William Harvey and his booklet on "The Motion of the Heart and Blood in Animals," 1628, Willis' translation; Auenbrugger and a translation of his original treaties on "Percussion of the Chest," 1761; Laennec and his treatise on "Diseases of the Chest and Mediate Auscultation," 1818; Jenner and his tracts on "Variolae Vaccinae," 1798 to 1800; Morton, and his remarks on "The Proper Mode of Administering Sulphuric Ether by Inhalation," 1847; Oliver Wendell Holmes, and his paper on "The Contagiousness of Puerperal Fever," 1843. Biographical sketches and lists of the writings of the various authors quoted accompany these papers. Dr. Camac says in his introduction that he has made no effort to present his subjects in chronological order, but his main idea has been to select these epoch-making articles—which he regards as masterpieces of scientific research—from the great mass of valueless or ephemeral writings among which the student must search for them if he desires to find them. The best English translation has been selected for articles which appeared in a foreign tongue. Dr. Camac has done an altogether admirable thing in bringing together these papers and putting them in shape that makes them at once accessible to every one. Naturally, those contributions which present the work of the Anglo-Saxon race have taken first place in the estimation of the

compiler, and one realizes in glancing over the list how large a part in bringing to the use of mankind resources in the healing art of the greatest magnitude the workers of that race have been permitted to play. Lister, Harvey, Jenner, Morton—Antisepsis, The Motion of the Heart and Blood, The Prevention of Small-pox, and the Abolition of Pain during Surgical Procedures—no similar list, in the far-reaching extent of the benefits that these have conferred, can be compiled.

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All contributions for Publication, Books for Review, and Exchanges should be sent to the Editorial Office, 145 Gates Ave., Brooklyn, N. Y.

Remittance for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS OF SURGERY,
227–231 South Sixth Street,
Philadelphia.

INDEX TO VOLUME LII.

A

Air Embolism, The Treatment of, 471; Passages, Foreign Bodies in, 123, 126.

Alba's Operation, 720.

ALLEN, DUDLEY P.: Removal of Lower Jaw for Giant-cell Sarcoma, 122.

AMERICAN SURGICAL ASSOCIATION, Transactions of the, 120.

Anæmia, Artificial, by Momburg's Method, 143.

Anæsthesia, Local, Laryngectomy during, 855; Spinal, Resection of Rectum under, 855.

Anæsthol Poisoning, 489.

Anastomosis by Invagination Method, End-to-end, Intestinal, 116, 130; The Rectosigmoidal Arterial, 529.

ANDERSON, JOHN: Primary Sarcoma of the Stomach, 506.

Aneurism of the Long Pipe Bones, 122.

Aneurisms, Large, Treatment of, with Gold Wire and Electrolysis, 561.

Angioma, Extensive, of the Upper Extremity: Varicose Veins Simulating a Femoral Hernia, 269.

Aorta, Abdominal, Graft of the Vena Cava on the, 462; Thoracic, Experimental Surgery of the, 83.

Appendicitis, The Origin of, 512; Relation between, and Disturbance in the Gastro-duodeno-hepatico-pancreatic Physiologic System, 801.

Appendicostomy, The Technic of, 808; For Ulcerative Colitis, 407.

Appendix, The Functions of the, 512.

ARMSTRONG, GEORGE E.: Abnormal Position of the Duodenum, 111; Epilepsy Following Fracture of the Skull, 140; Formation of New Sphincter after Removal of Rectum for Cancer, 140.

Arterial Anastomosis, the Recto-sigmoidal, 529.

Arteries, Anomalous Renal, and their Relation to Hydronephrosis, 814; the Determination of the Efficiency of Collateral Circulation, before Occlusion of the Great, 126.

Asphyxia, Traumatic, 408.

Atony of the Bladder without Obstruction or Signs of Organic Nervous Disease, 577.

B

Bacterins in Suppurative Bone and Joint Disease, 136.

BARRINGER, BENJAMIN S.: The Cystoscopic Examination in Renal Tuberculosis, 239.

BARTLETT, WILLARD: A Simple Method of Suturing all Hollow Viscera, 520.

BEVAN, ARTHUR DEAN: Resections of the Rectum for Cancer, 139.

Bevan's Operation for Undescended Testis—Discussion of, 821, 860.

Bladder, Urinary, Atony of the, without Obstruction or Signs of Organic Nervous Disease, 577; Distention in the Treatment of Cystitis, 664; Intraperitoneal Operations upon, 657; Note on

the Removal of Carcinoma of the Fundus of the, 654.

BLAIR, VILRAY PAPIN: A Suggestion for the Treatment of Air Embolism, 471.

BLAKE, JOSEPH A.: Partial Removal of Phalanx for Sarcoma, 122; Resection of the Rectum for Cancer—Combined Operation for, 139.

Blood Transfusion in Hæmophilia, 457; Transfusions of, Three Consecutive, for Profound Secondary Anæmia, 710.

BLOODGOOD, JOSEPH C.: Benign Bone Cysts, Ostitis Fibrosa, Giant-cell Sarcoma, and Bone Aneurism of the Long Pipe Bones, 145; Cause of Epilepsy after Fracture of the Skull, 141; Resection of the Rectum for Cancer, 139.

Blunt Force Intestinal Lesions, 358.

Bone, Autoplastic Transplantation of, 217; Cement for Filling Cavities in, 122; Cysts, Benign, 122, 145; and Joint Suppurations, Therapy by Bacterins and Tuberculins, 136; Metastases of Hypernephroma, 533.

Bones, Aneurism of the Long Pipe, 122, 145; Giant-cell Sarcoma of, 122, 145; Neoplasms and Other Tumors Involving the Maxillary, 186.

BOTTOMLEY, JOHN T.: Congenital Strictures of the Ureter, 597.

BRAASCH, WILLIAM F.: Recent Developments in Pyelography, 645.

Breast, Cystic Disease of the, 253, 283.

BREWER, GEORGE E.: Surgical Treatment of Œsophageal Diverticula, 125.

Bronchus, Metallic Foreign Bodies in, 767; Removal of a Tack from, 123.

BUNTS, FRANK E.: Decompression Operation after Fracture of the Base of the Skull, 140; The Pneumatic Tourniquet, 700.

C

CAMAC, C. M.: Epoch-making Contributions to Medicine and Surgery, Review of, 864.

Cardia, Cancer of the Œsophagus and, 67.

CARREL, ALEXIS: Experimental Surgery of the Thoracic Aorta and Heart, 83; Graft of the Vena Cava on the Abdominal Aorta, 462.

Carrel's End-to-end Suture Method of Transfusion, 433.

Cholecystitis, Calculous, 278.

Cholelithiasis, Simulating Carcinoma, 404.

Chromo-ureteroscopy in Functional Diagnosis, 569.

Clavicle, Sarcoma of the, and Results following Total Excision, 776.

COLEY, WILLIAM B.: Sarcoma of the Clavicle, and Results following Total Excision, 776; Sarcoma of the Lower Jaw Treated by Mixed Toxins, 397; Sarcoma of the Upper Jaw Treated by Mixed Toxins, 398.

Colitis, Appendicostomy for, Ulcerative, 407.

Collateral Circulation, Determination of Efficiency of, before Occlusion of Great Arteries, 126.

Colostomy, Permanent, 384.

Contusions of Intestines, 358.

COPLIN, W. M. L.: The Relation of Ductless Glands to Surgery, 570; Tumors of the Jaw, 565.

CORNER, EDRED M.: On the Function of the Appendix, and the Origin of Appendicitis, 512; Statistics about Fractures and Refractures of the Patella, 707.

CUMSTON, CHAS. GREENE: Primary Congenital Hydronephrosis, 626.
CUSHING, HARVEY: Operations on the Hypophysis, 120.
Cystic Disease of the Breast, 253, 283.
Cystitis, Chart to Aid in Treatment of, by Distention of the Bladder, 664.
Cystoscopic Examination in Renal Tuberculosis, 239.
Cystotomy, Intraperitoneal, 657.
Cysts of Bone, Benign, 145.

D

DA COSTA, JOHN C., JR.: Vaccine Therapy as an Adjunct to Surgery, 135.
DAVIS, CARL B.: The Rectosigmoidal Arterial Anastomosis, 529.
DAVIS, JOHN STAIGE: Treatment of Scalping Accidents, 721.
DEAVER, JOHN B.: Intestinal Anastomosis by the Invagination Method, 130; Vaccine Therapy as an Adjunct to Surgery, 135.
Diabetic Gangrene of Foot, Effect of Artificial Arterial Hyperæmia on, 713.
Differential Pressure in the Treatment of Empyema, 502.
Dislocation, Backward, of the Upper End of the Ulna, 215; of the Wrist-joint, Spontaneous Forward, 229.
Diverticulitis, Intestinal, 262; of the Sigmoid, Perforating, 558.
DOWNS, WILLIAM A.: Treatment of Undescended Testis, 861; Volvulus of the Small Intestine in a Child, 402.
Drainage, Wright's Solution of Sodium Citrate and Sodium Chloride for, 541.
Ductless Glands, the Relation of the, to Surgery, 545, 570.
Duodenal Fistula following Nephrectomy for Stone, 259; Ulcer, by G. B. A. Moynihan—Review of, 572.
Duodenum, Abnormal Position of, 111.

E

EBERTS, VON: The Use of Differential Pressure in the Treatment of Empyema, 502.
EISELSBERG, FREIH., VON: Operations upon the Hypophysis, 1, 120; Use of Boiling Water in Operations for Removal of Malignant Tumors of Bone, 123.
Elbow-joint, Ultimate Result of Excision of the, 272.
ELIOT, ELLSWORTH, JR.: Appendicostomy for Ulcerative Colitis, 407; Cholelithiasis, Simulating Carcinoma, 404; Recurrent Floating Cartilage in Knee-joint, 405; Relaxed Internal Ligament of Knee, 406; Simple Fracture of Vertebra with Contusion of the Cord, 409; Traumatic Asphyxia, 408.
ELSBERG, CHARLES A.: Clinical Experience with Intratracheal Insufflation, with Remarks upon the Value of the Method of Thoracic Surgery, 25; Sarcoma of Spine, 414.
Embolism, Air, the Treatment of, 471.
Empyema, Differential Pressure in the Treatment of, 502.
Enteroptosis, 566.
Epoch-making Contributions to Medicine and Surgery and the Allied Sciences, Collected by C. M. Camac, Review of, 864.
Epulis, Surgical Aspect of, 489.
Excision of the Elbow-joint, Ultimate Result of, 272.
Exophthalmic Goitre, Partial Thyroidectomy for, 713.

F

Facial Nerve, Preservation of the Submaxillary Branch of the, in Operations on the Neck, 487.
FARR, CHARLES E.: Preservation of the Submaxillary Branch of the Facial Nerve in Operations on the Neck, 487.
Feeding, Transgastric Jejunal, 373.
Femoral Hernia, Is the Sac of Congenital Origin, or Acquired? 668.
FERGUSON, ALEX. H.: Combined Operation for Resection of the Rectum for Cancer, 139.
Fistula-enterostomy of Von Stubenrauch, the Proposed, 380.
Foreign Bodies in the Bronchus, 123, 767.
FOWLER, GEO. RYERSON: Metallic Foreign Bodies in the Bronchus, 767.
Fracture of the Head and Neck of the Radius, 207; of Leg, Old Ununited, Injection of Blood for, 403; of the Patella Treated by Subcutaneous Purse-string Suture, 267; of Tibia and Fibula, Value of Tenotomy in Some Cases of, 276.
Fractures and Dislocations, Review of Stimson on, 719; Method of Overcoming the Shortening in Old, 141.

G

Gangrene of the Foot, Diabetic, Effect of Artificial Arterial Hyperæmia in, 713; of the Lung, 554.
Gastroptosis, 569.
GERSTER, ARPAD G.: Fractures of the Pelvis, 143.
GIBSON, CHARLES L.: End-to-end Intestinal Anastomosis by the Invagination Method, 116, 130.
GIRVIN, JOHN H.: Calculous Cholecystitis, 278.
Goitre, Exophthalmic, Partial Thyroidectomy for, 713.
GOODMAN, CHAS.: Blood Transfusion in Hæmophilia, 457.
Graft of the Vena Cava on the Abdominal Aorta, 462.
GREEN, NATHAN W.: Artificial Respiration and Intrathoracic Œsophageal Surgery, 58; Cancer of the Œsophagus and Cardia, 67.

H

Hæmophilia, Blood Transfusion in, 457.
HAGNER, FRANCIS R.: Note on the Removal of Carcinoma of the Fundus of the Urinary Bladder, 654.
HALSTEAD, A. E.: Operative Treatment of Tumors of the Hypophysis, 120.
HALSTED, WILLIAM S.: Myxoma of the Humerus, 122; Occlusion of Arteries, 129.
HAMMOND, ROLAND: Fracture of the Head and Neck of the Radius, 207.
HARRIS, M. L.: Gun-shot Wound of Pancreas, 135.
HARTE, RICHARD H.: Extension by Pulleys in Fractures Treated by Open Incision, 142.
HARTWELL, JOHN A.: Intestinal Diverticulitis, 262.
HAUBOLD, H. A.: Plastic Repair of the Thumb, 536.
Heart, Experimental Surgery of the, 83; Treatment of Wounds of the, 96.
Hernia, Femoral, Formation of the Sac of, 668; Femoral, Varicose Veins Simulating a, 269; Use of Silver Wire and Linen Thread for the Cure of, 678.
HITZROT, JAMES H.: Duodenal Fistula following Nephrectomy for Stone, 259; Gangrene of the

Lung, 554; Result following Excision of Fractured Carpal Scaphoid and Dislocated Semilunar, 261.
HODGE, EDWARD B.: Volvulus of the Sigmoid, 270.
Hollow Viscera, Simple Method of Suturing, 520.
HORSLEY, J. S.: Suture of the Recurrent Laryngeal Nerve, 287.
HOTCHKISS, LUCIUS W.: Resection of Both Upper Jaws for Carcinoma, 562.
Humerus, Myxoma of, Conservative Operation for, 122.
HUNT, J. RAMSAY: Symptomatology and Surgical Treatment of Spinal Cord Tumors, 289, 412.
Hydronephrosis, Primary Congenital, 626; Relation of Anomalous Renal Arteries to, 814.
Hyperæmia, Artificial Arterial, in Threatening Gangrene of the Foot, 713.
Hypernephroma, Bone Metastasis in, 553.
Hypophysis, Operations upon the, 1, 120; Tumor of the, 15, 120.

I

Infantilism from Tumor of the Hypophysis, 15, 120.
Innominate Bone, Fractures and Dislocations of the, 143.
Insufflation, Intratracheal, First Case of Thoracotomy in the Human Being under Anæsthesia by, 30; Intratracheal, Value of, for Thoracic Surgery, 23.
Intestinal Anastomosis, End-to-end, by the Invagination Method, 116, 130; Diverticulitis, 262; Lesions Produced by Blunt Force, 358; Obstruction, Postoperative, 135.
Intestine, Volvulus of the Small, in a Child, 402.
Intratracheal Insufflation, Clinical Experience with, 23; Insufflation, First Case of Thoracotomy in the Human Being under Anæsthesia by, 30; Insufflation, Value of, for Thoracic Surgery, 715.
Invagination Method of Intestinal Anastomosis, 116, 130.

J

JACOBSON, NATHAN: Excision of Upper Jaw for Giant-cell Sarcoma, 123; Removal of Bean from Bronchus, 125.
JANEWAY, HENRY H.: Autoplastic Transplantation of Bone, 217; Cancer of the Œsophagus and Cardia, 67.
Jaw, Epulis and Sarcoma of the, Surgical Aspect of, 565; Lower, Partial Removal of, for Sarcoma, 122; Sarcoma of, Result of Treatment with Mixed Toxins, 397; Surgical Aspect of Sarcoma of the, 493; Upper, Sarcoma of, Treated by Mixed Toxins, 398.
Jaws, Resection of Both Upper, for Carcinoma, 562.
JUDD, EDWARD STARR: Treatment of Tuberculous Glands of the Neck, 758.

K

KANAVAL, A. B.: Operations on the Hypophysis, 121.
Keetley, Charles Robert Bell, Obituary Memoir of, 850.
KELLY, HOWARD A.: Chart to Aid in Treatment of Cystitis by Distention of the Bladder, 664.
KEMP, ROBT. COLEMAN: Diseases of the Stomach and Intestines, Review of, 718.
Kidney Diagnosis, Chromo-ureteroscopy in Functional, 569; Primary Congenital Hydronephrosis of, 626; Recent Developments in Dilating Pelvis of the, 645; Tuberculosis of and Cystoscopic Examination in, 239.

KILIANI, OTTO G. T.: Tumor of the Spinal Cord, 411.
KIRCHNER, WALTER C. G.: Treatment of Wounds of the Heart, 96.
Knee-joint, Recurrent Floating Cartilage in, 405; Relaxed Internal Ligament of, 406.

L

Laryngeal Nerve, Recurrent, Suture of the, 287.
Larynx, Excision of, for Cancer under Local Anæsthesia, 855.
LEE, BURTON J.: Rupture of the Liver followed by Subphrenic Abscess, 858.
LEWIS, DEAN: Pathology of Tumors of the Hypophysis, 121.
LILIENTHAL, HOWARD: First Case of Thoracotomy in the Human Being under Anæsthesia by Intratracheal Insufflation, 30; Perforating Diverticulitis of the Sigmoid, 558; Permanent Colostomy, 384; Resection of Rectum by Combined Method in Two Stages, 855; Treatment of Undescended Testis, 860.
Liver, Acute Yellow Atrophy from Anæsthol Poisoning, 489; Cirrhosis of the, Treated by the Talma Operation, Result after Nine Years, 560; Rupture of the, followed by Left Subphrenic Abscess, 858.
Lung, Gangrene of the, 554.
LUSK, WILLIAM C.: Resection of the Male Rectum for Cancer by the Combined Method in Two Stages, 836, 855.
LYLE, H. M.: Alba's Operation, 720; Injection of Blood for Old Ununited Fracture of Leg, 403.

M

MACAUSLAND, W. R.: Fracture of the Tarsal Scaphoid, 845.
MACCARTY, WILLIAM CARPENTER: Relation between the Appendix and Disturbance in the Gastroduodeno - hepatico - pancreatic Physiological System, 801.
MACDONALD, ARCHIBALD L.: Anomalous Renal Arteries and Relation to Hydronephrosis, 814.
Macrodactylia, Congenital, 562.
Madelung's Deformity of the Wrist, 229.
MARTIN, EDWARD: Method of Overcoming Shortening in Old Fractures Treated by the Open Method, 141.
MATAS, RUDOLPH: Artificial Anæmia by Momburg's Method, 144; Determination of the Efficiency of the Collateral Circulation, before Occlusion of the Great Arteries, 126; The Filling of Bone Cavities, 122; Misplaced Spleen, 138; Resection of Pancreas, 135.
MATHEWS, FRANK S.: Myeloma of the Long Bones, 388; Responsibility of the Tonsil in Tuberculous Adenitis, 753; Sarcomatous Transformation of Uterine Fibroids, 401.
Maxillary Bones, Neoplasms and Other Tumors Involving the, 186.
MAYLARD, A. ERNEST: Primary Sarcoma of the Stomach, 506.
MAYO, CHARLES H.: Occlusion of Common Carotid for Arteriovenous Aneurism of Orbit, 130.
MAYO, WILLIAM J.: Resections of Rectum for Cancer, 139; Transgastric Excision of Calloused Ulcer of the Posterior Wall of the Body of the Stomach, 797.
MCCLURE, R. D.: Transfusion by Carrel's End-to-end Suture Method, 433.
MCCURDY, STEWART L.: Neoplasms and Other Tumors involving the Maxillary Bones, 186.

McGrath, Bernard Francis: Relation between Appendicitis and Disturbance in the Gastro-duodeno-hepatico-pancreatic Physiological System, 801.
McGuigan, Hugh: A Suggestion for the Treatment of Air Embolism, 471.
Meltzer, S. J.: Experiments with Intratracheal Insufflation, 716.
Meyer, Willy: Effect of Artificial Arterial Hyperæmia in Threatening Gangrene of the Foot, 713; Partial Thyroidectomy for Exophthalmic Goitre, 713; Resection of the Pancreas, 135; Some Observations regarding Thoracic Surgery in Human Beings, 34; Value of Intratracheal Insufflation for Thoracic Surgery, 715.
Mixter, Samuel J.: Surgical Treatment of Œsophageal Diverticula, 124; Tumor of the Hypophysis, 15, 120.
Momburg's Method of Artificial Anæmia, 143.
Morris, Robert T.: Treatment of Perforating Diverticulitis, 559; Treatment of Undescended Testis, 860.
Moschcowitz, Alexis V.: Anatomy and Treatment of Undescended Testis, 821, 860; Neuralgia of Second Division of Fifth Nerve: Kocher's Operation, 257; Trigeminal Neuralgia: Hartley-Krause Operation, 258.
Moynihan, G. B. A.: Duodenal Ulcer, Review of, 572.
Müller, George P.: Enteroptosis, 566.
Murphy, John B.: Surgical Treatment of Œsophageal Diverticula, 125.
Murray, R. W.: Is the Sac of Femoral Hernia of Congenital Origin, or Acquired? 668.
Myeloma of the Long Bones, 388.

N

Neck, Preservation of the Submaxillary Branch of the Facial Nerve in Operations on the, 487; Responsibility of the Tonsil in Tuberculous Glands of, 753; Treatment of Tuberculous Glands of the, 758.
Nephrectomy for Stone, Duodenal Fistula following, 259.
Neuralgia, Trigeminal, 257, 258.
New York Surgical Society, Transactions of the, 257, 397, 415, 553, 710, 855.

O

Obstruction of Bowels, Postoperative, 131.
Ochsner, Albert J.: Extension after Fractures, 142.
Ochsner and Thompson: Surgery and Pathology of the Thyroid and Parathyroid Glands, Review of, 575.
Œsophageal Diverticula, Surgical Treatment of, 124; Surgery, Intrathoracic, and Artificial Respiration, 58.
Œsophagus and Cardia, Cancer of the, 67.
Omentum, Sarcoma of the, 399.
Osteitis Deformans, 415; Fibrosa, 122, 145.

P

Pancreas, Resection of the, 134.
Patella, Fracture of the, Treated by Subcutaneous Purse-string Suture, 267; Statistics about Fractures and Refractures of the, 707.
Peck, Charles H.: Excision of the Rectum for Carcinoma by the Perineal Route, 556.
Pelvis, Fractures of the, 143.
Peritonitis, Pneumococcic, 274.
Pfeiffer, D. B.: Vaccine Therapy as an Adjunct to Surgery, 135.

Phalanx, Partial Removal of, for Sarcoma, 122.
PHILADELPHIA ACADEMY OF SURGERY, Transactions of the, 267, 565, 570.
PILCHER, LEWIS S.: Obituary Memoir of Charles Robert Bell Keetley, 850.
Pineal Gland, Operations upon the, 1, 120; Tumor of the, 15, 120.
Pipe Bones, Sarcoma and Aneurism of the, 145.
Plastic Repair of the Thumb, 536.
Pneumatic Tourniquet, 700.
POOL, EUGENE H.: Bone Metastasis in Hypernephroma, 533; Carcinoma of Accessory Thyroid, 711; Congenital Macrodactylia, 562; Three Consecutive Transfusions of Blood for Profound Secondary Anæmia, 711; Transfusion by Carrel's End-to-end Suture Method, 433.
Pyelography, Recent Developments in, 645.

Q

QUACKENBOSS, ALEX.: Tumor of the Hypophysis, 15, 120.

R

Radius, Fracture of the Head and Neck of the, 207; Pathological Fracture of, with Osteitis Deformans, 415.
RANSOHOFF, JOSEPH: Foreign Bodies in the Air-passages, 126.
Rectosigmoidal Arterial Anastomosis, 529.
Rectum, the Excision of, for Carcinoma, by the Perineal Route, 556; Resection of, for Cancer, by the Combined Method in Two Stages, 836, 855; Resections of, for Cancer, 139.
Renal Arteries, Relation of Anomalous, to Hydronephrosis, 814; Tuberculosis, Cystoscopic Examination in, 239.
Respiration, Artificial, and Intrathoracic Œsophageal Surgery, 58.
ROBERTS, JOHN B.: Fracture of the Patella Treated by Subcutaneous Purse-string Suture, 267.
RODMAN, WILLIAM L.: Conservative Excision of Sarcoma of Lower Jaw, 122; Gastroptosis, 569.
RUSSEL, JAMES I.: Osteitis Deformans with Pathological Fracture of the Radius, 415.

S

Sarcoma of the Clavicle, and Results following Total Excision, 776; of the Jaw, 493; of Lower Jaw Treated by Mixed Toxins, 397; of the Omentum, 399; of the Stomach, Primary, 506; of the Upper Jaw Treated by Mixed Toxins, 398.
Scalping Accidents, Treatment of, 721.
Scaphoid, Fractured Carpal, and Dislocated Semilunar, Result following Excision of, 261; Tarsal, Fracture of the, 845.
SCHWYZER, ARNOLD: Transgastric Jejunal Feeding, 373.
SCUDDER, CHARLES L.: The Bone Metastases of Hypernephroma, 533.
SHERMAN, HARRY M.: Dislocations of the Os Innominatum, 143; Inflammatory Tumor Mistaken for Sarcoma, 138; Method of Powerful Extension after Fractures, 142; Use of Salt Solution in Bone Cavities, 122.
Sigmoid, Perforating Diverticulitis of the, 558; Volvulus of the, 270.
Silver Wire and Linen Thread, Use of, for the Cure of Hernia, 678.
Skull, Operative Treatment of Fracture of the Base of, 140.

Sodium Citrate and Sodium Chloride, Wright's Solution for Drainage, 541.

SPEESE, JOHN M.: The Surgical Aspect of Epulis and Sarcoma of the Jaw, 493, 565.

SPENCER and GASK: The Practice of Surgery, Review of, 576.

Spinal Cord, Contusion of the, with Simple Fracture of Vertebra, 409; Tumor of the, 411, 412; Tumors, Symptomatology and Surgical Treatment of, 289.

Splenectomy for Displacement and Twisted Pedicle, 138.

STIMSON, LEWIS A.: Treatise on Fractures and Dislocations, Review of, 719.

STOKES, A. C.: Spontaneous Forward Dislocation of the Wrist-joint, 229.

Stomach and Intestines, Review of Kemp on Diseases of the, 718; Primary Sarcoma of the, 506; Transgastric Excision of Ulcer of Posterior Wall of, 797.

STONE, HARVEY B.: Intestinal Lesions Produced by Blunt Force, 358.

Stubenrauch, Von, proposed Fistulo-enterostomy of, 380.

Subphrenic Abscess, Sequel to Rupture of the Liver, 858.

Surgery, The Practice of, Review of Spencer and Gask's book on, 576.

SUTTON, WALTER S.: The Proposed Fistulo-enterostomy of Von Stubenrauch, 380.

Suturing All Hollow Viscera, Simple Method for, 520.

SWEET, J. EDWIN: The Relation of Ductless Glands to Surgery, 545, 570.

T

Talma Operation, Result after Nine Years, 560.

Tarsal Scaphoid, Fracture of the, 845.

TAYLOR, ALFRED S.: Total Laryngectomy under Local Anæsthesia, 855.

TAYLOR, WILLIAM J.: Cystic Disease of the Breast, 253, 283; Extensive Angioma of the Upper Extremity; Varicose Veins Simulating a Femoral Hernia, 269.

TENNANT, CHAUNCEY E.: Intraperitoneal Cystotomy, 657.

Tenotomy, Value of, in Some Cases of Fracture of Tibia and Fibula, 276.

Testis, Anatomy and Treatment of Undescended, 821, 860.

THOMAS, B. A.: Cromo-ureteroscopy in Functional Kidney Diagnosis, 569.

THOMAS, J. LYNN: Control of Hemorrhage by Means of the Forceps-tourniquet, 704.

Thoracic Aorta and Heart, Experimental Surgery of the, 83; Surgery on Human Beings, Some Observations Regarding, 34; Surgery, The Value of Intratracheal Insufflation in, 23, 715.

Thumb, Plastic Repair of the, 536.

Thyroid, Accessory, Carcinoma of, 711; and Parathyroid Glands, Surgery and Pathology of the, Review of, 575.

Thyroidectomy, Partial, for Exophthalmic Goitre, 713.

Tibia and Fibula, Value of Tenotomy in Some Cases of Fracture of, 276.

Tonsil, Responsibility of the, in Tuberculous Adenitis, 753.

TOREK, FRANZ: Anæsthol Poisoning Causing Acute Yellow Atrophy of Liver, 489.

Tourniquet-forceps, Control of Hemorrhage by Means of, in Major Amputations, 704.

Tourniquet, Pneumatic, 700.

Transfusion by End-to-end Suture Method, 433; in Hæmophilia, 457.
Transfusions of Blood, Three Consecutive, for Profound Secondary Anæmia, 710.
Transgastric Jejunal Feeding, 373.
Transplantation of Bone, 217.
Trigeminal Neuralgia: Hartley-Krause Operation, 258.
Tuberculins in Mixed Suppurative Bone and Joint Disease, 136.
Tuberculosis of the Kidney, Cystoscopic Examination in, 239; of the Neck Glands, Responsibility of the Tonsil in, 753; of the Neck Glands, Treatment of, 758.

U

Ulna, Backward Dislocation of the Upper End of the, 215.
Ununited Fracture of the Leg, Injection of Blood for, 403.
Ureter, Congenital Strictures of the, 597.

V

Vaccine Therapy as an Adjunct to Surgery, 135.
VANDERVEER, ALBERT: Treatment of Œsophageal Diverticula, 126.
Vena Cava, Graft of the, on the Abdominal Aorta, 462.
Vertebra, Simple Fracture of, with Contusion of the Cord, 409.
Volvulus of the Sigmoid, 270; of the Small Intestine in a Child, 402.

W

WALKER, JOHN B.: Treatment of Undescended Testis, 861.
WALKER, J. W. THOMSON: Atony of the Bladder without Obstruction or Signs of Organic Disease, 577.
WARBASSE, JAMES P.: Backward Dislocation of the Upper End of the Ulna, 215.
WHARTON, HENRY R.: Pneumococcic Peritonitis, 274; Ultimate Result of Excision of the Elbow-joint, 272; Value of Tenotomy in Some Cases of Fracture of Tibia and Fibula, 276.
WIENER, JOSEPH: Silver Wire and Linen Thread for the Cure of Hernia, 678.
WILLARD, DE FORREST: Enlarged Thymus as a Cause of Death under Ether, 125.
WOOD, B. E.: Fracture of the Tarsal Scaphoid, 845.
WOOLSEY, GEORGE: Cirrhosis of the Liver Treated by Talma Operation; Result after Nine Years, 560; Postoperative Intestinal Obstruction, 131; Symptomatology and Surgical Treatment of Spinal Cord Tumors, 289; Treatment of Large Aneurisms by the Induction of Wire and the Use of Electrolysis, 561.
Wright's Solution of Sodium Citrate and Sodium Chloride for Drainage, 541.
Wrist-joint, Spontaneous Forward Dislocation of the, 229.

Y

YEOMANS, FRANK C.: Technic of Appendicostomy, 808.

Vol. LII DECEMBER, 1910 No. 6

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TABLE OF CONTENTS

ORIGINAL MEMOIRS

I. The Treatment of Scalping Accidents. By JOHN STAIGE DAVIS, M.D., *of Baltimore, Md.* 721

II. The Responsibility of the Tonsil in Tuberculous Adenitis. By FRANK S. MATHEWS, M.D., *of New York* 753

III. Treatment of Tuberculous Glands of the Neck. By EDWARD STARR JUDD, M.D., *of Rochester, Minnesota* 758

IV. Metallic Foreign Bodies in a Bronchus. By GEORGE RYERSON FOWLER, M.D., *of Brooklyn, N.Y.* 767

V. Sarcoma of the Clavicle: End-Results following Total Excision. By WILLIAM B. COLEY, M.D., *of New York* 776

VI. Transgastric Excision of Calloused Ulcer of the Posterior Wall of the Body of the Stomach. By WILLIAM J. MAYO, M.D., *of Rochester, Minnesota* 797

VII. Relation between Appendicitis and Disturbance in the Gastro-duodeno-hepatico-pancreatic Physiological System. By WILLIAM CARPENTER MACCARTY, M.D., and BERNARD FRANCIS MCGRATH, M.D., *of Rochester, Minnesota* 801

VIII. The Technic of Appendicostomy. By FRANK C. YEOMANS, M.D., *of New York* 808

IX. Anomalous Renal Arteries and Their Relation to Hydronephrosis. By ARCHIBALD L. MCDONALD, M.D., *of Grand Forks, North Dakota* 814

X. The Anatomy and Treatment of Undescended Testis; with Especial Reference to the Bevan Operation. By ALEXIS V. MOSCHCOWITZ, M.D., *of New York*..... 821

XI. Resection of the Male Rectum for Cancer, by the Combined Method in Two Stages. By WILLIAM C. LUSK, M.D., *of New York* 836

XII. Fracture of the Tarsal Scaphoid. By W. R. MACAUSLAND, M.D., and B. E. WOOD, M.D., *of Boston, Mass.*..... 845

Charles Robert Bell Keetley, F.R.C.S. By LEWIS S. PILCHER, M.D. 850

TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

STATED MEETING, October 12, 1910 856

BOOK REVIEW

Camac: Epoch-making Contributions to Medicine and Surgery and the Allied Sciences... 864

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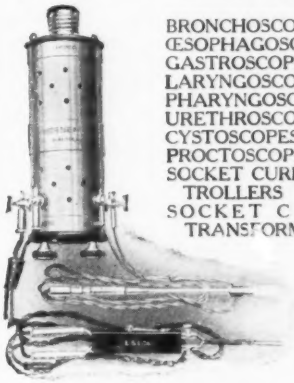

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